

Figure 1. Sensor Placement Relative To Bit

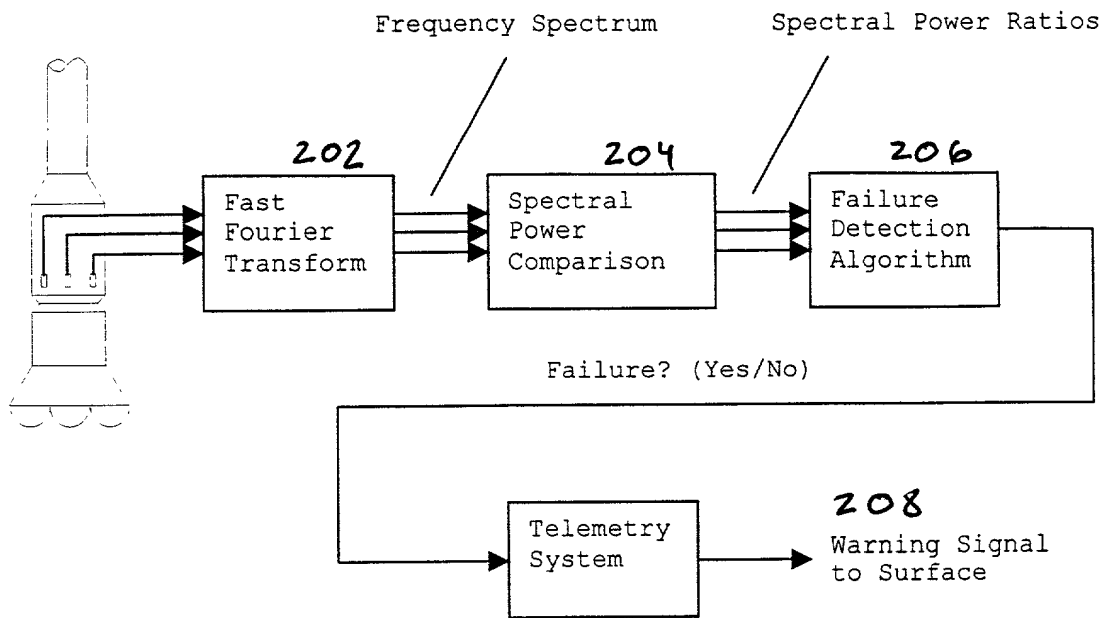


Figure 2

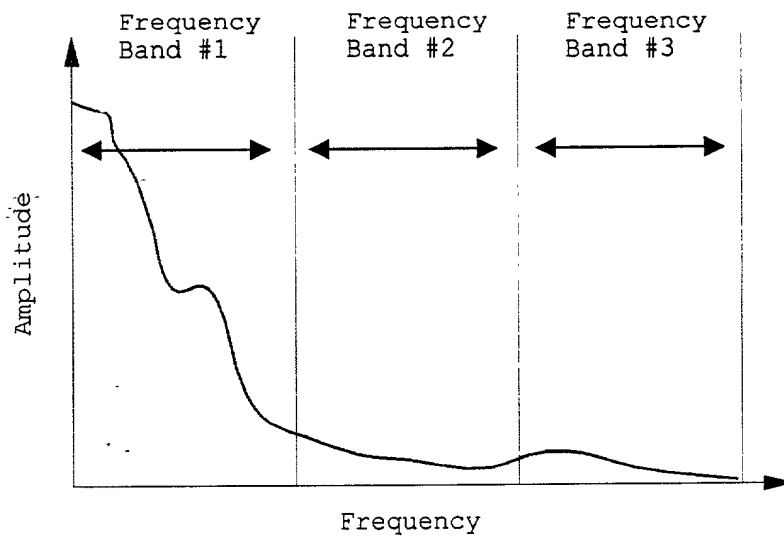


Figure 3. Frequency Band Arrangement

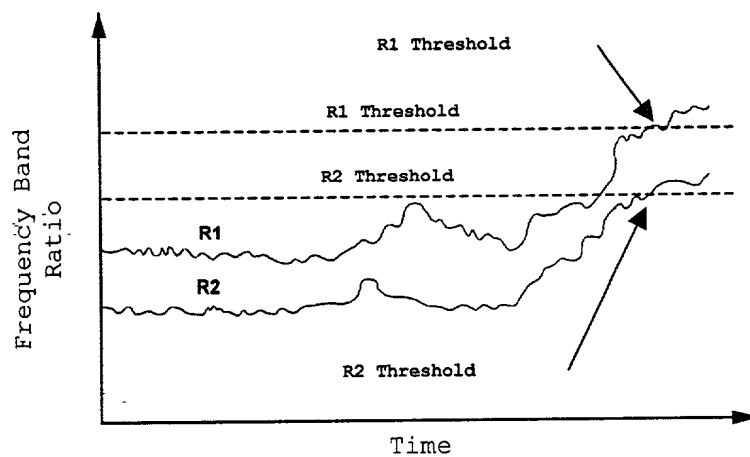


Figure 4. Threshold Failure Detection

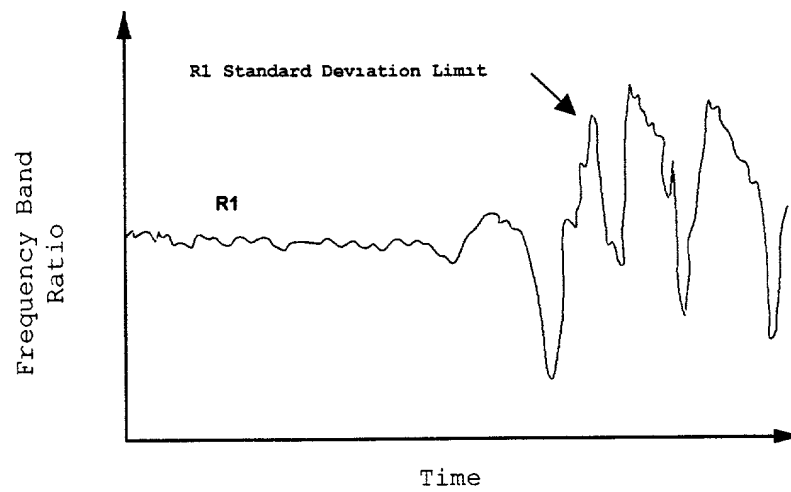


Figure 5 Statistical Failure Detection

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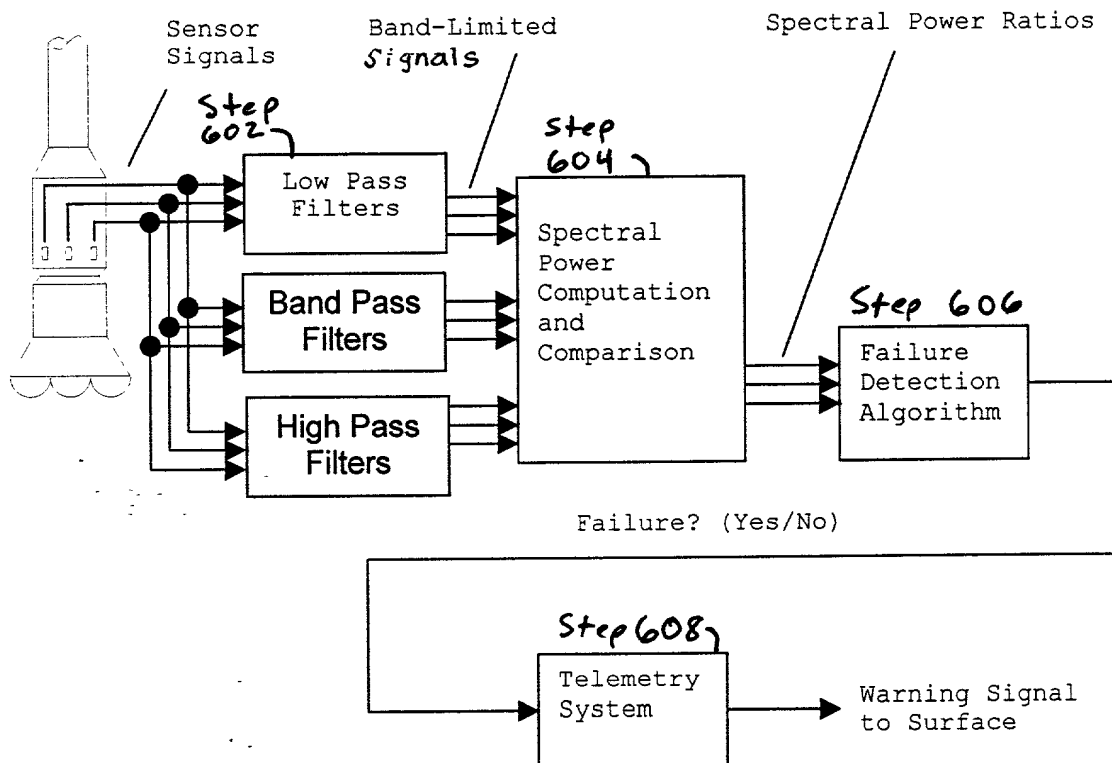


Figure 6 SPRA Method Using Analog Filters Spectral Power Separation

TOP SECRET

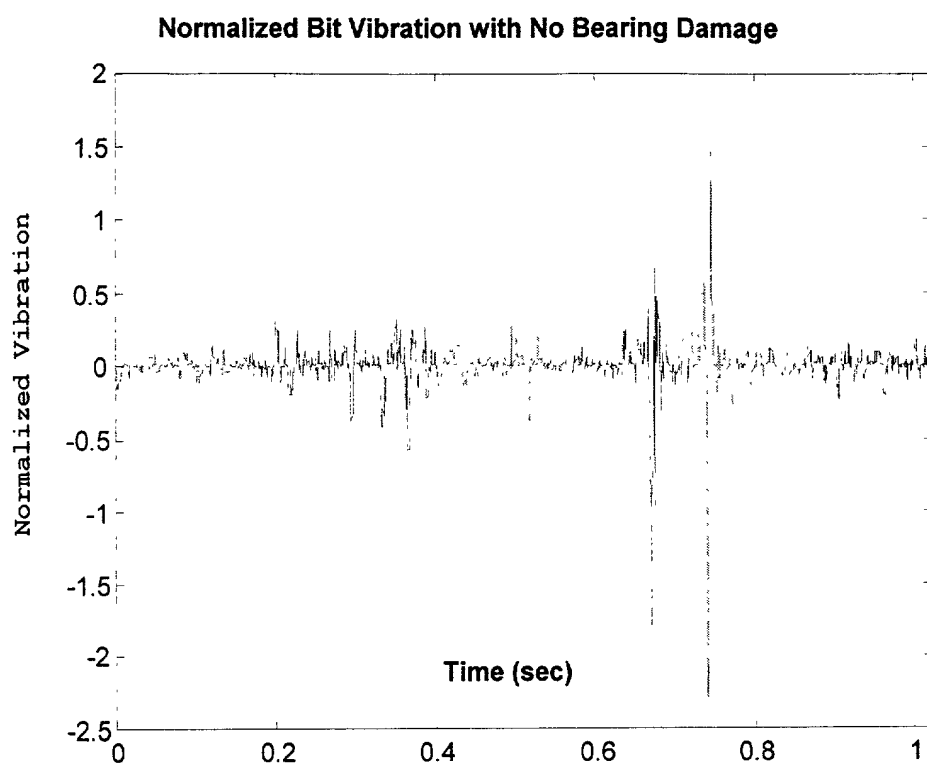


Figure 7.

Discrete FFT of Vibration Data with No Bearing Damage

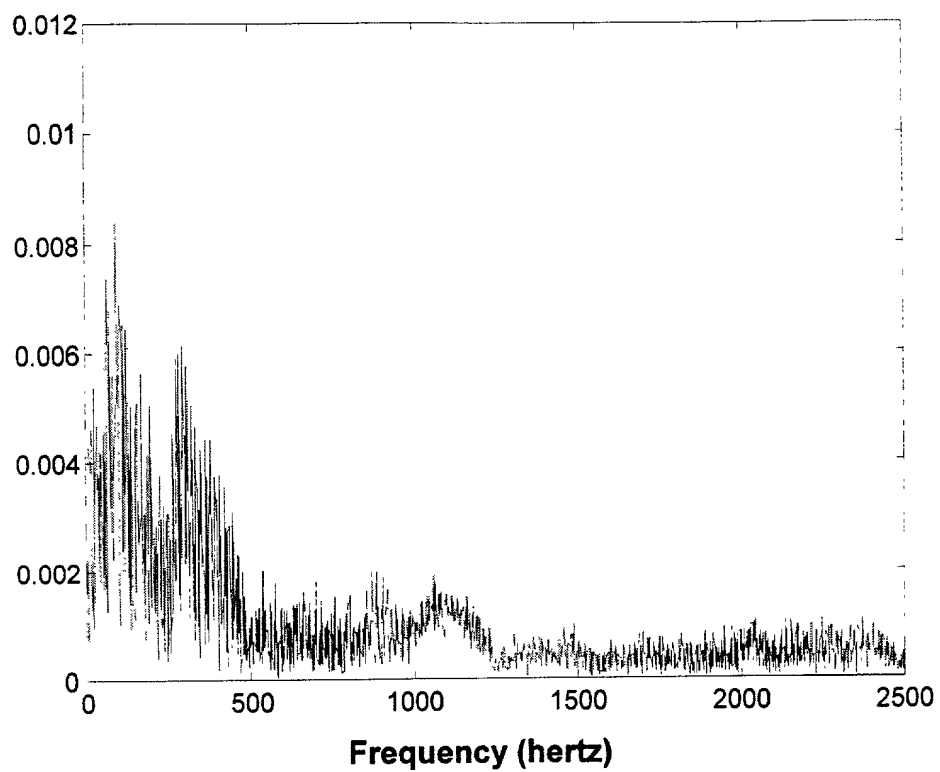


Figure 8.

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TOTAL 507900K

Spectral Power Analysis Bearing with No Damage

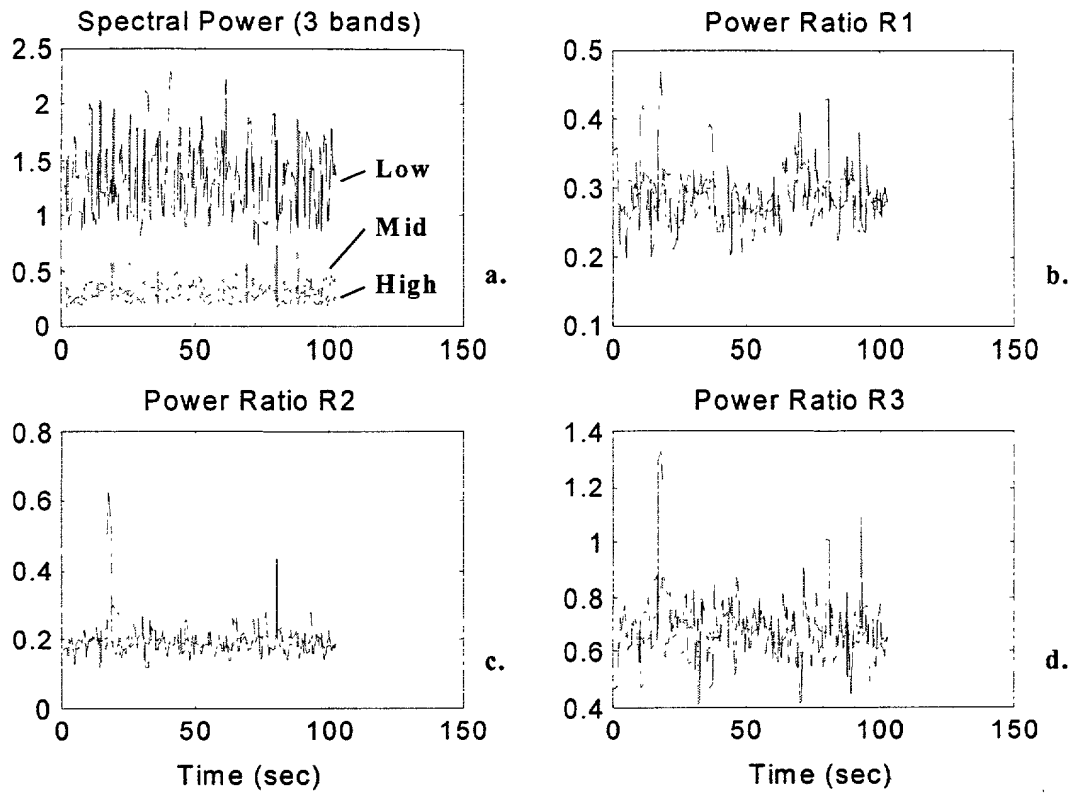


Figure 9.

FOUO "SECRET"

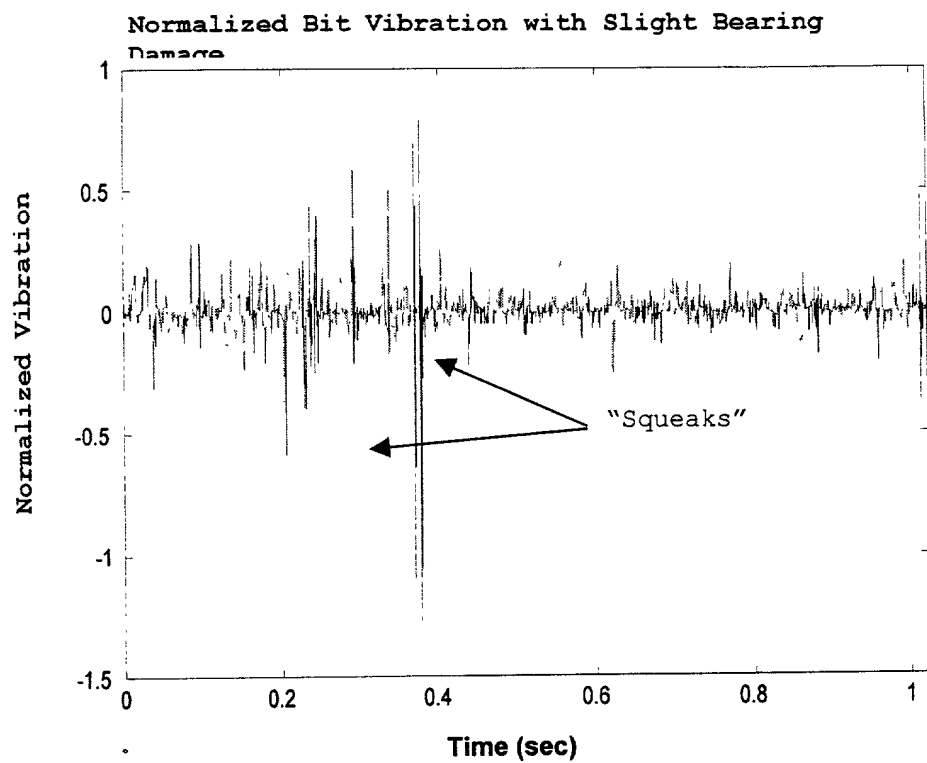


Figure 10.

Discrete FFT of Vibration Data with Initial Bearing Damage

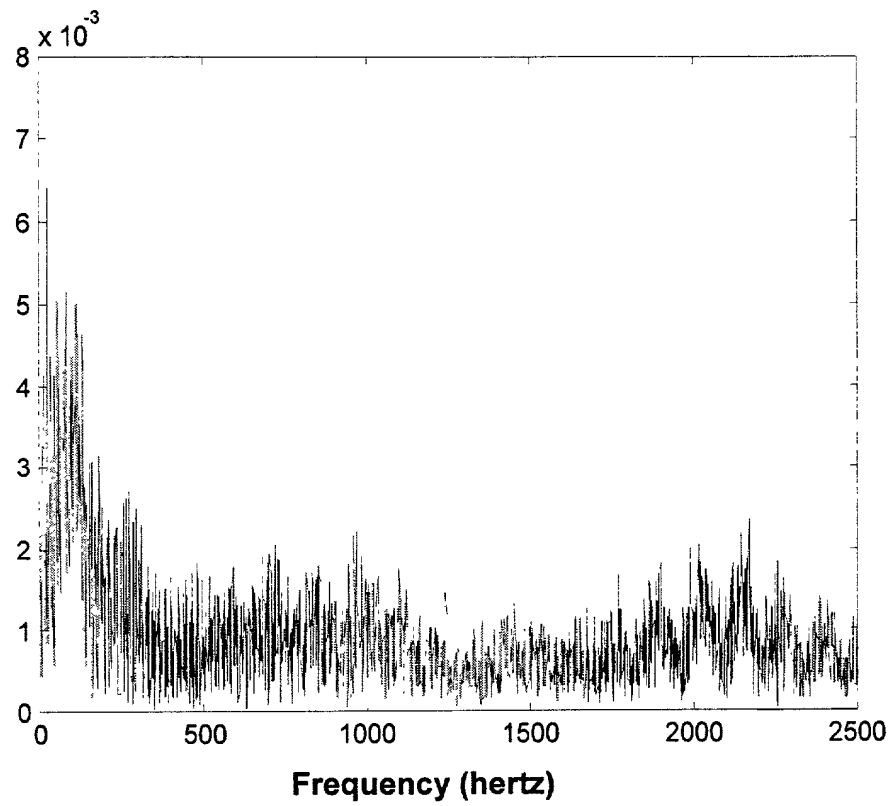


Figure 11.

Spectral Power Analysis for Slightly Damaged Bearing

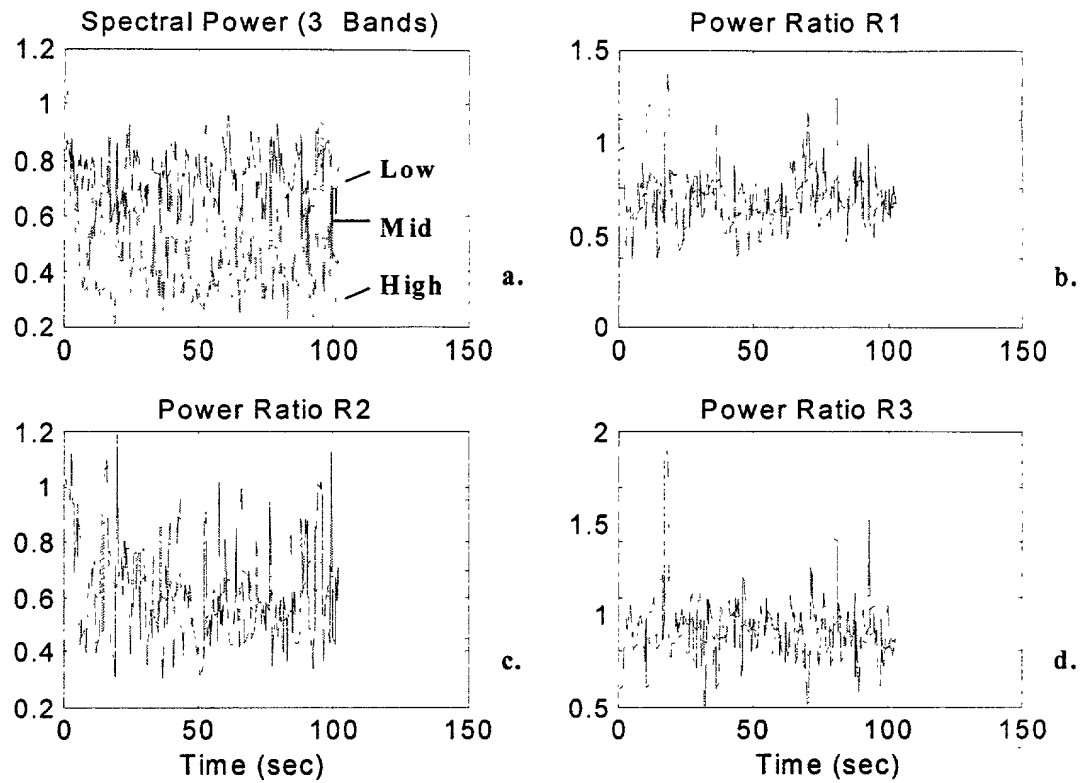


Figure 12.

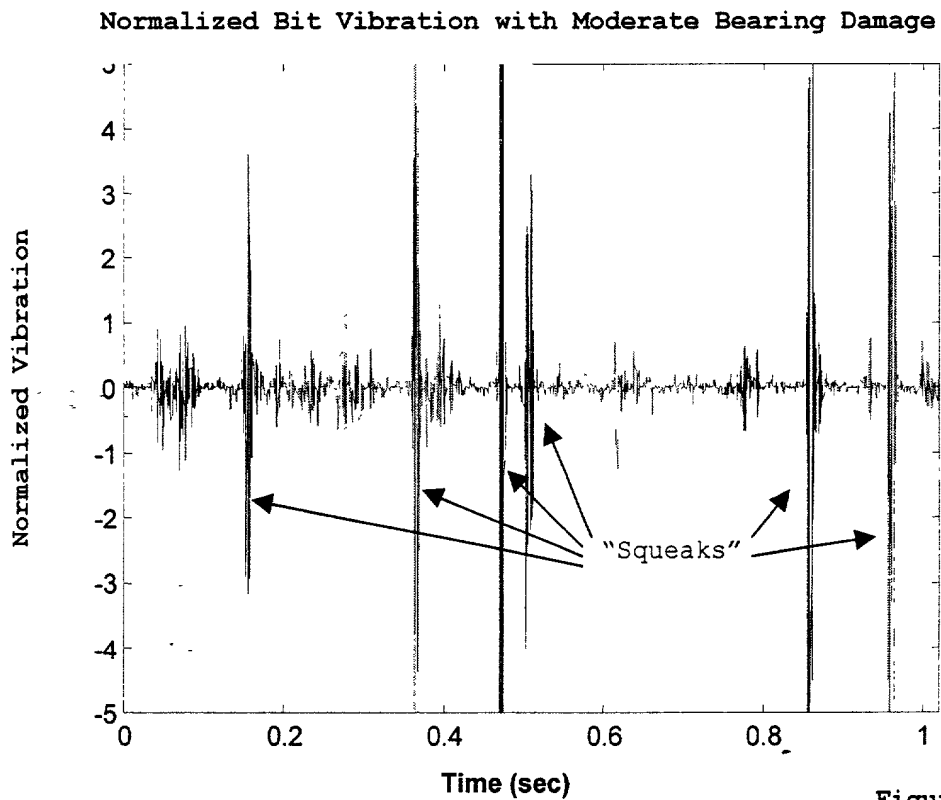


Figure 13.

Discrete FFT of Vibration Data for Moderate Bearing Damage

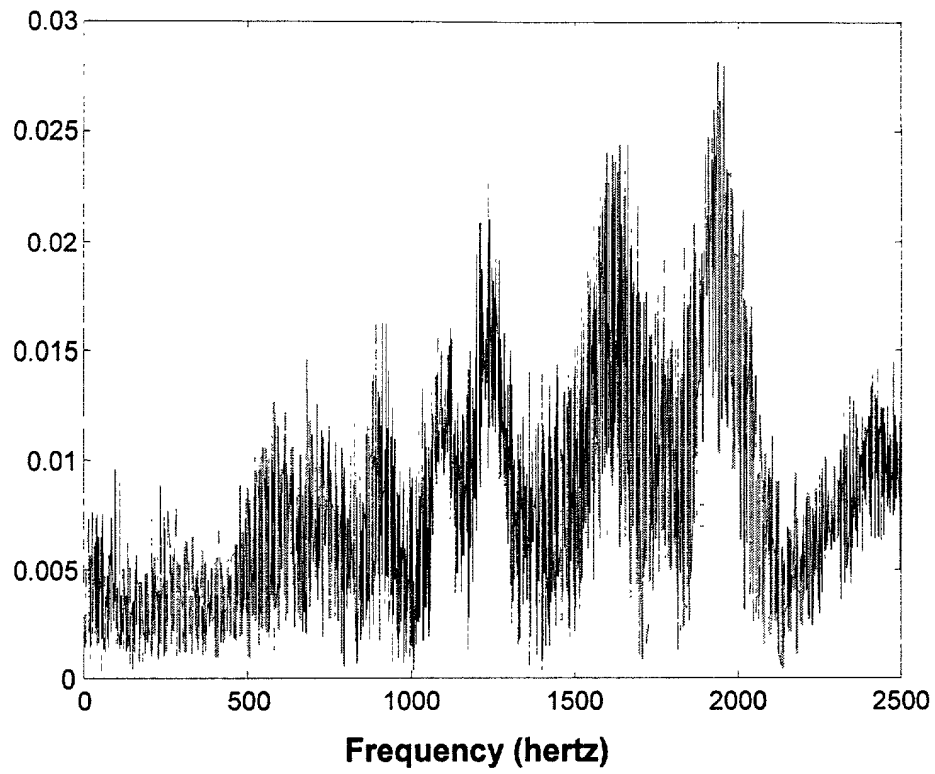


Figure 14.

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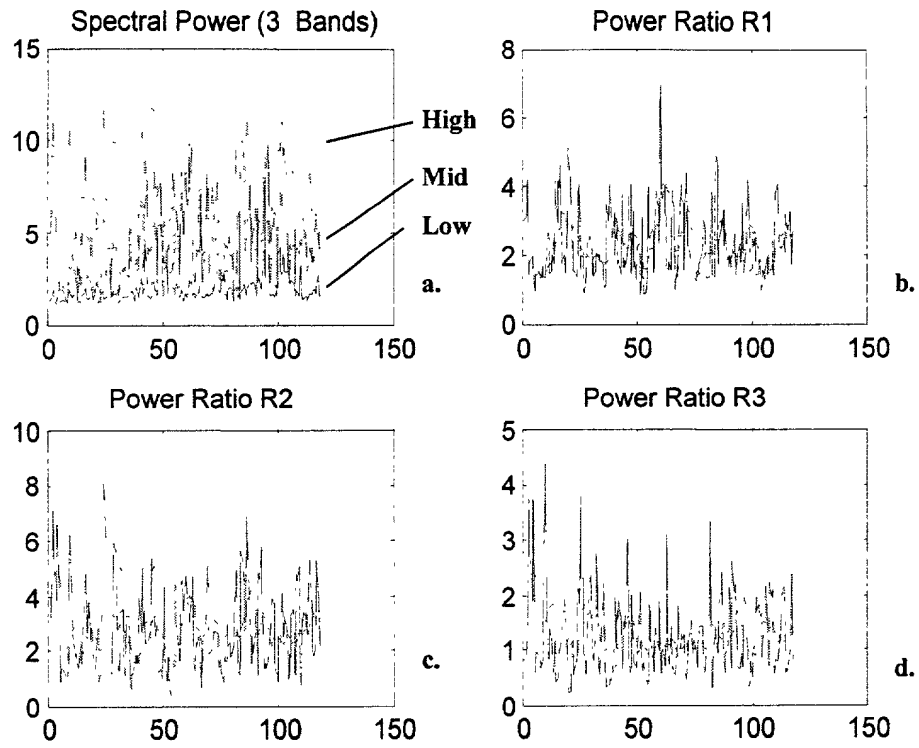


Figure 15.

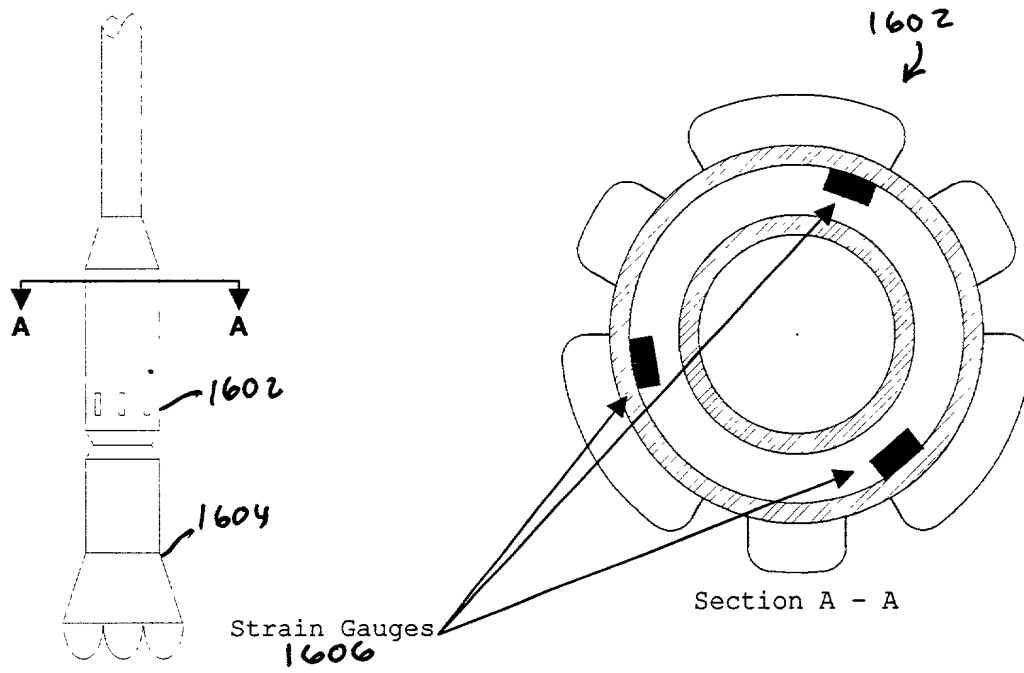


Figure 16. Strain Gauge Placement In Sensor Housing

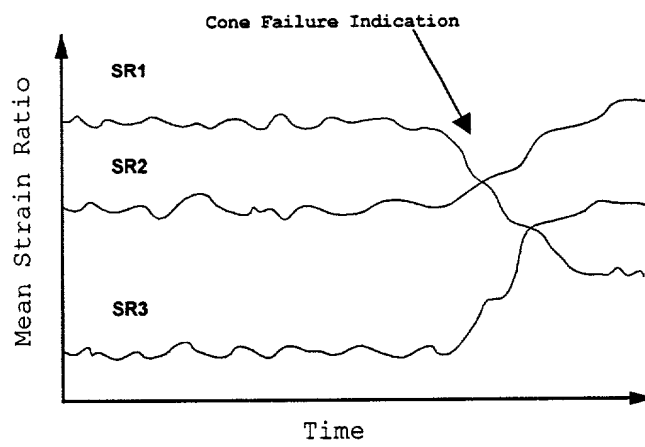


Figure 17. Failure Indication (MSRA Method)

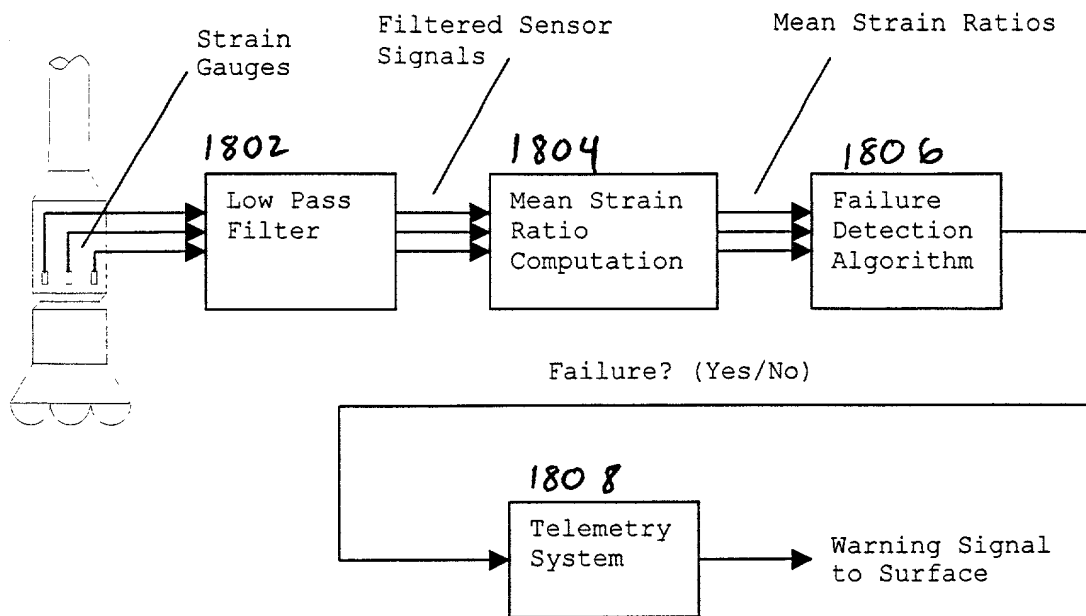


Figure 18. Schematic of MSRA Failure Detection Scheme

Strain Gauge for No Bearing Damage

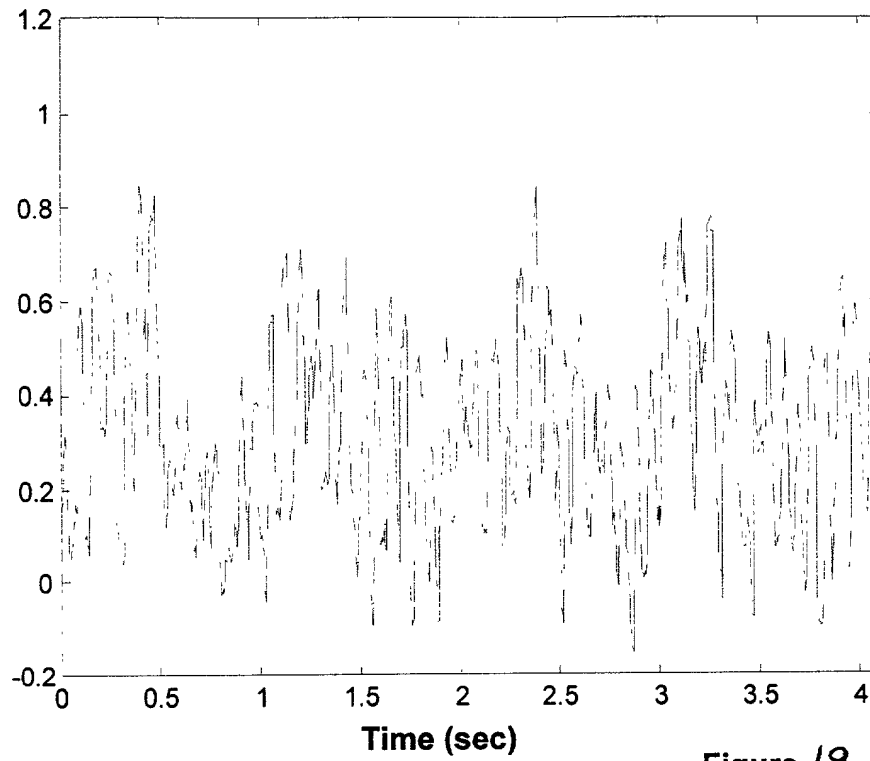


Figure 19

Discrete FFT of Strain Gauge Signal for No Bearing Damage

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Discrete FFT of Strain Gauge Signal for No Bearing Damage

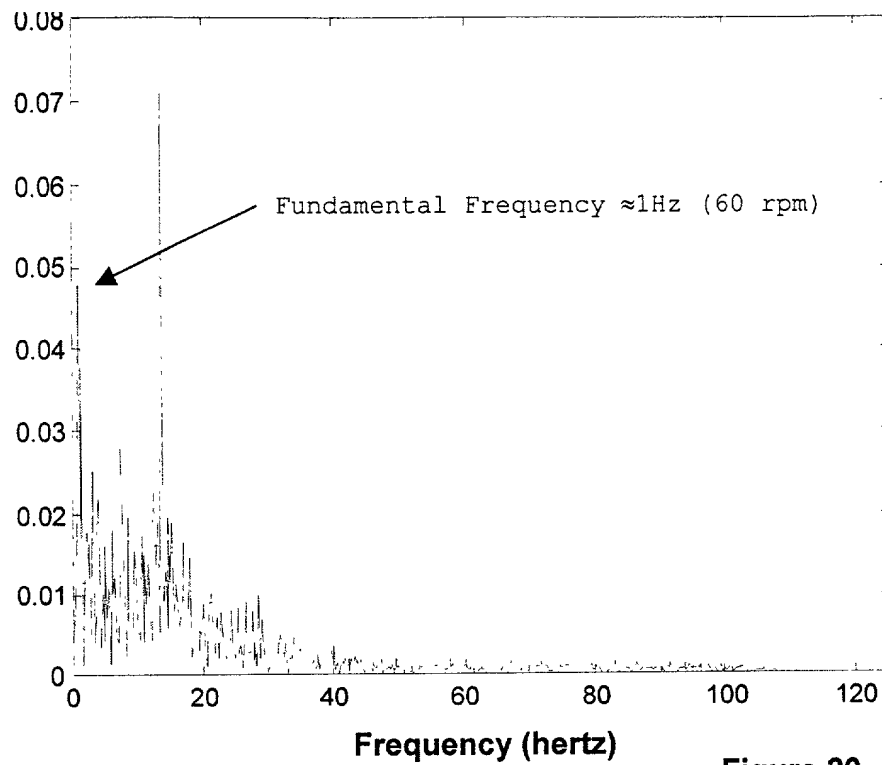


Figure 20.

100400-10101

Mean Strain Analysis for Bearing with No Damage

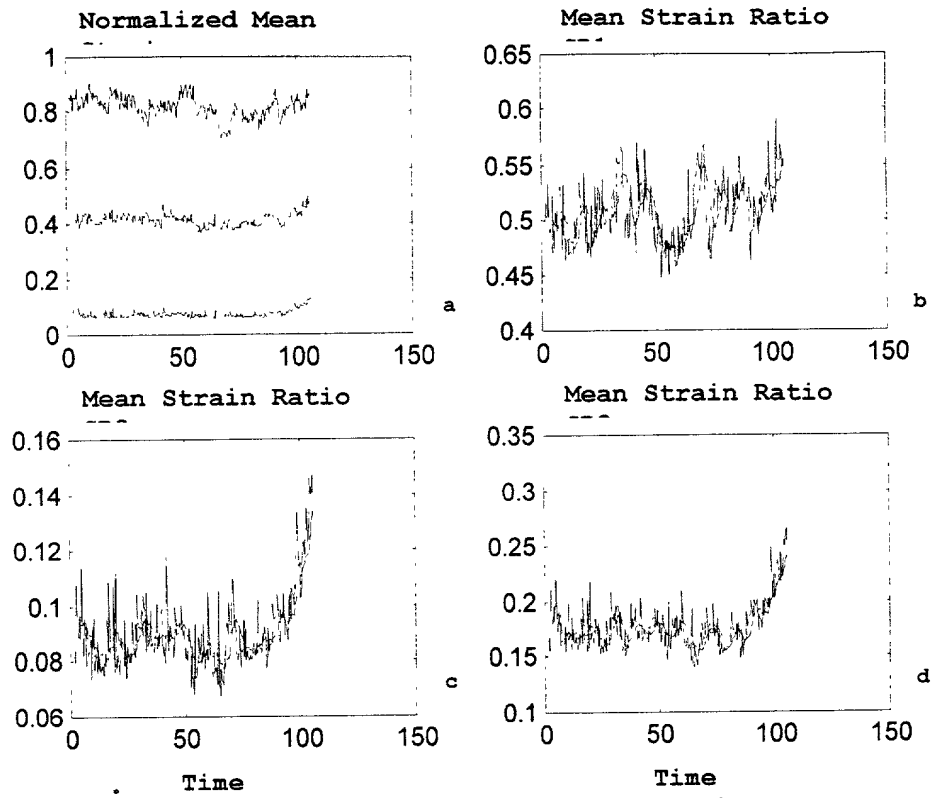


Figure 21.

Strain Gauge Signal when Bearing Lightly Damaged

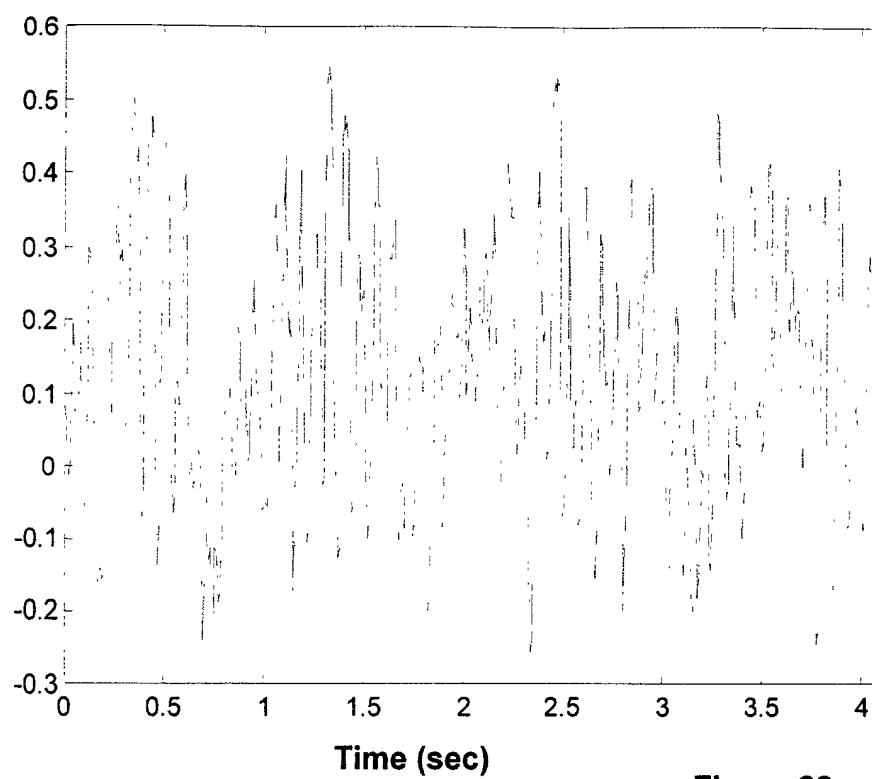


Figure 22.

10036105-10101
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Discrete FFT of Strain Gauge Signal for Light Bearing Damage

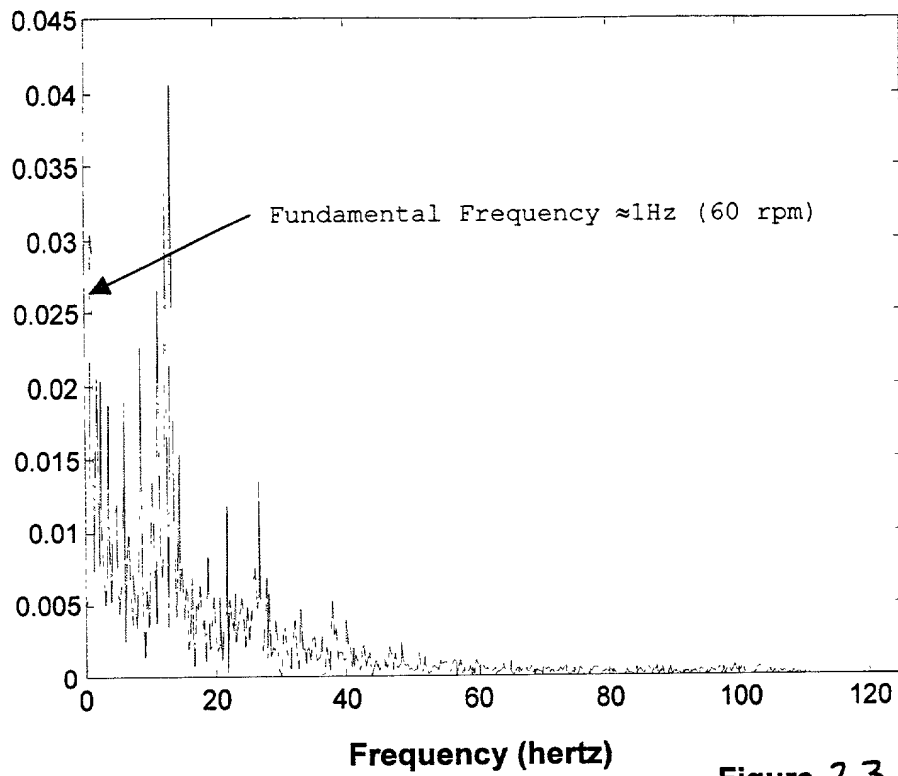


Figure 23

10036105-10701
FOUO "SOT 3E00T"

Mean Strain Analysis for Bearing with Light Damage

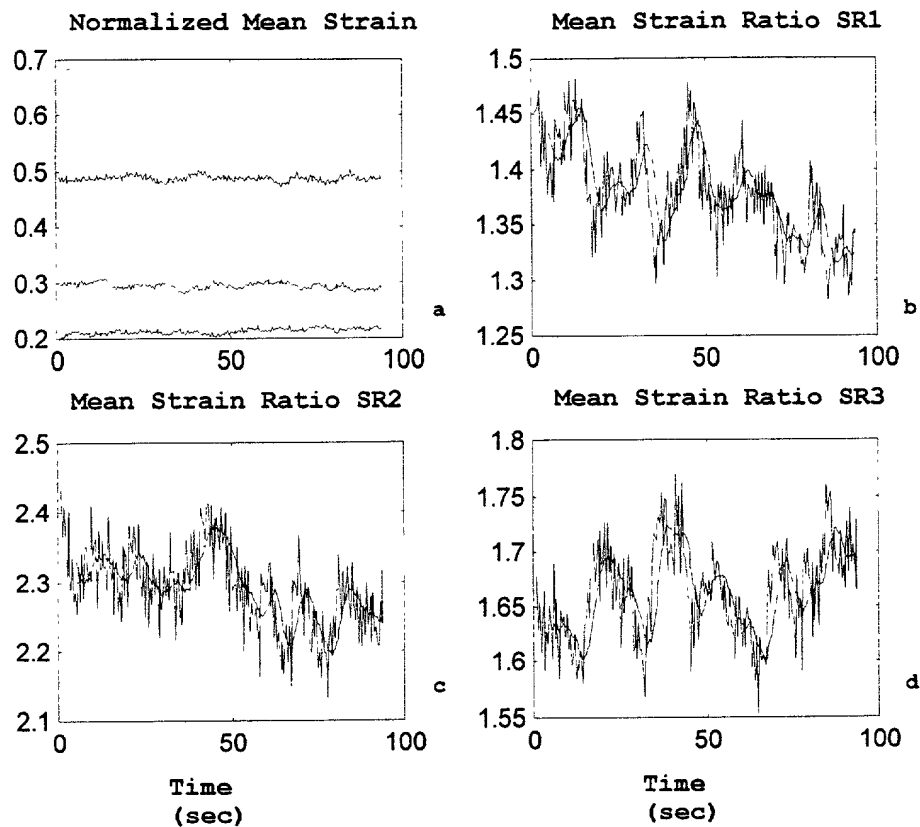


Figure 24

100603 10101
T02T0T 50T9E00T

Strain Gauge Signal when Bearing Moderately Damaged

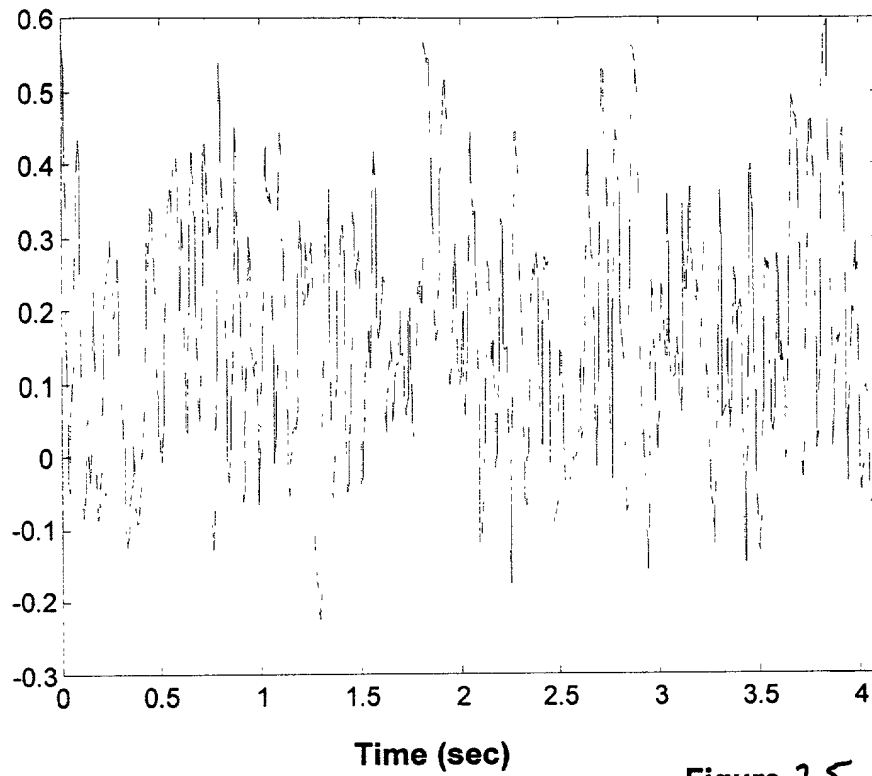


Figure 25

Discrete FFT of Strain Gauge Signal for Moderate Bearing Damage

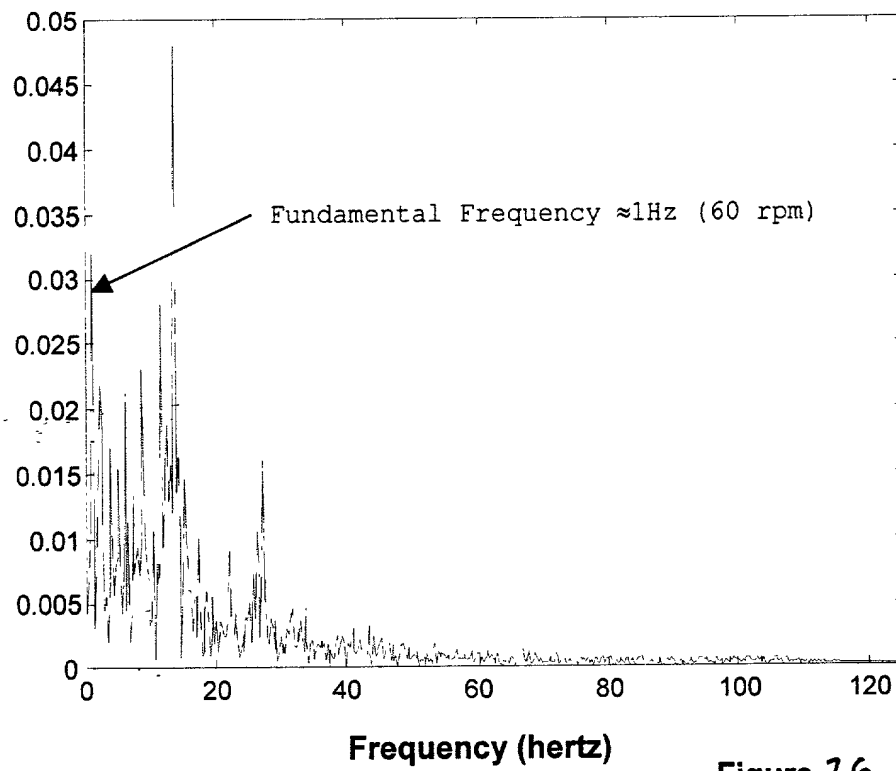


Figure 26

Mean Strain Analysis for Bearing with Moderate Damage

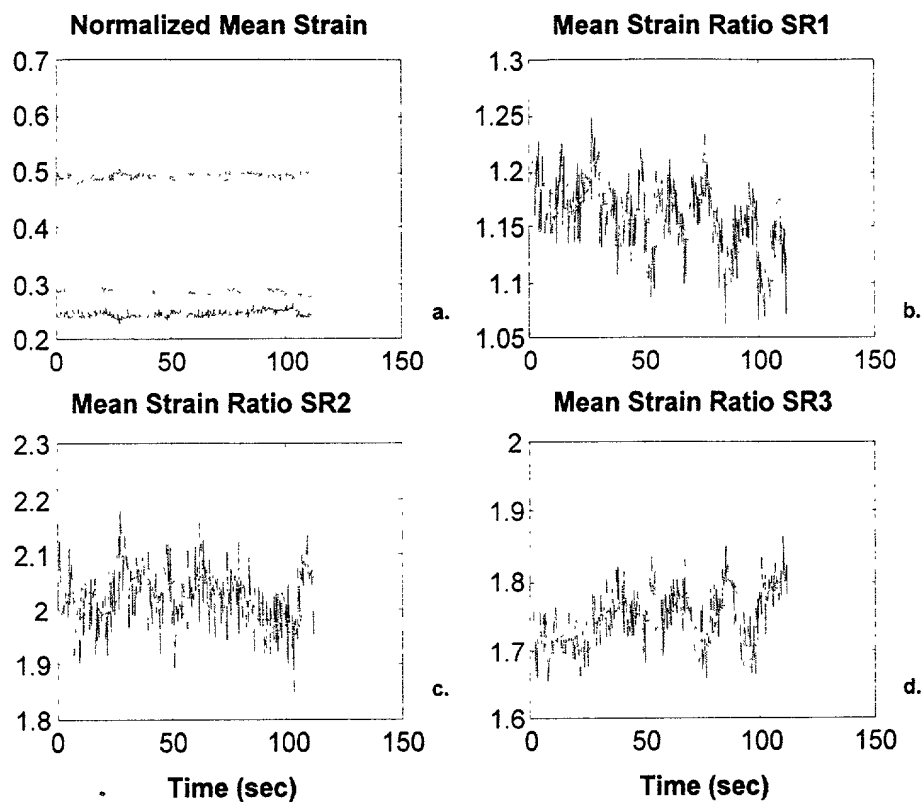


Figure 27

Strain Gauge Signal with Bearing In Early Failure

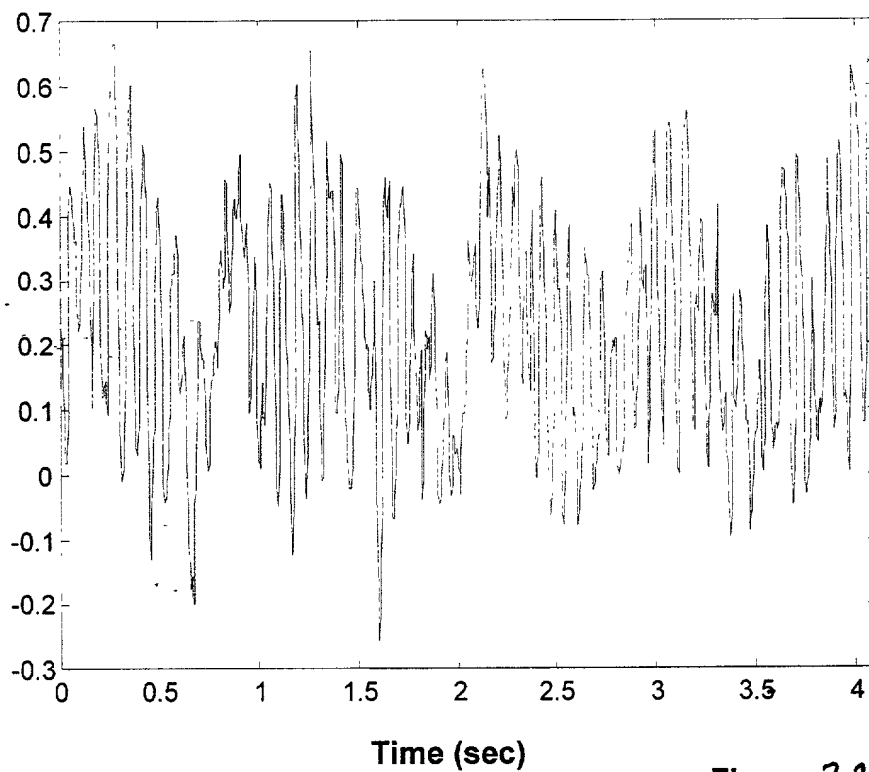


Figure 28

Discrete FFT of Strain Gauge Signal for Bearing In Early Failure

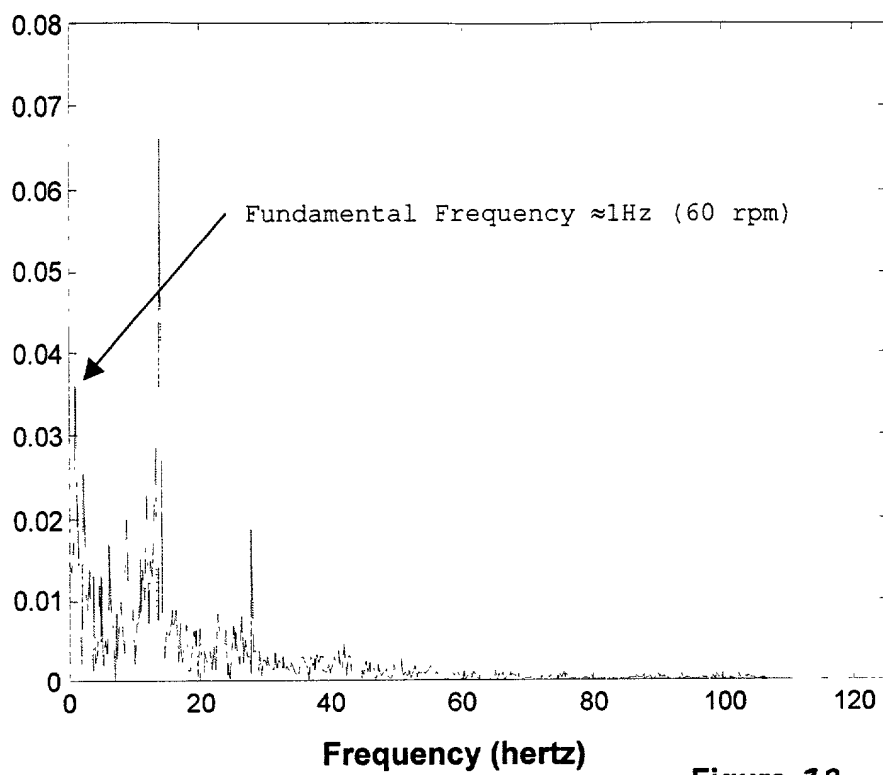


Figure 29

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TOTAL 5075000

Mean Strain Analysis for Bearing in Early Failure

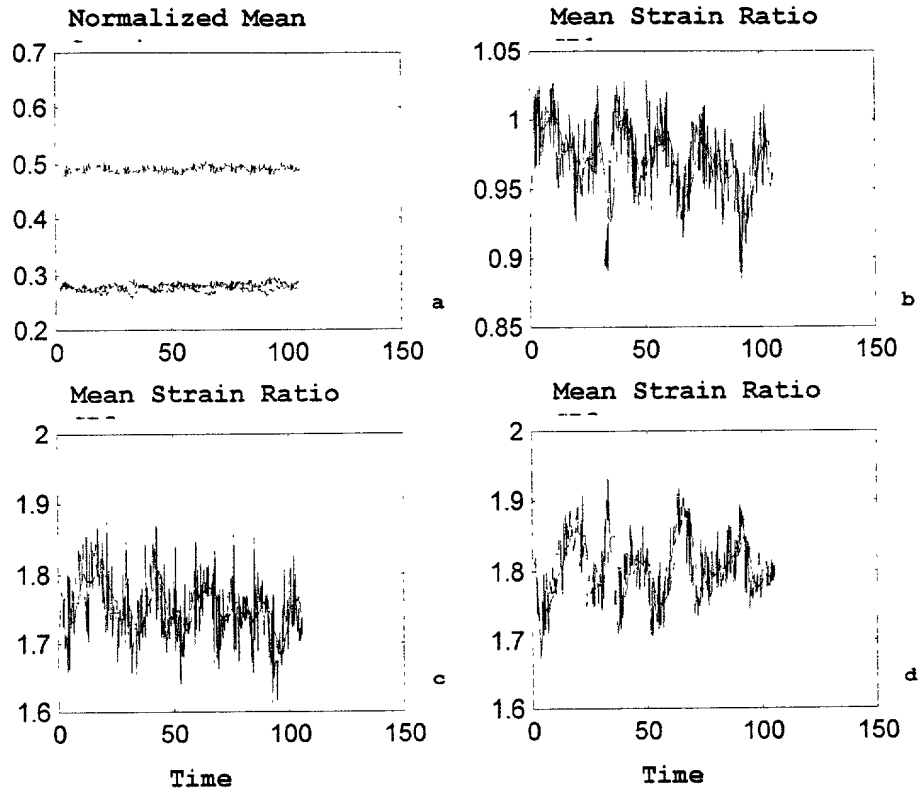


Figure 30.

Mean Strain Analysis for Shifting Load Condition

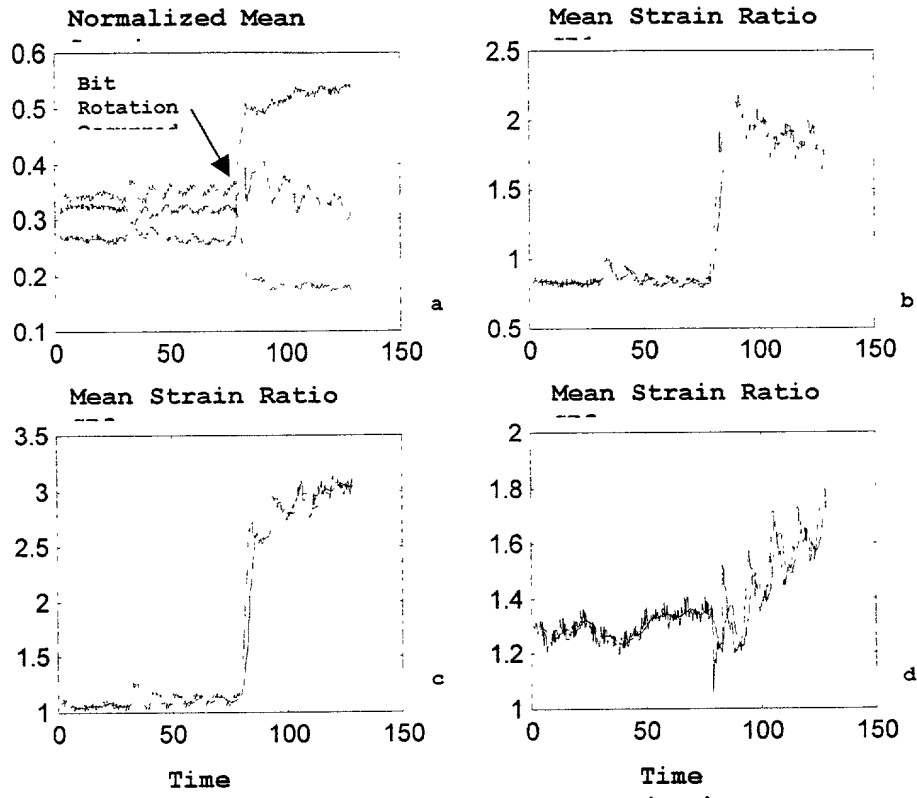


Figure 31.

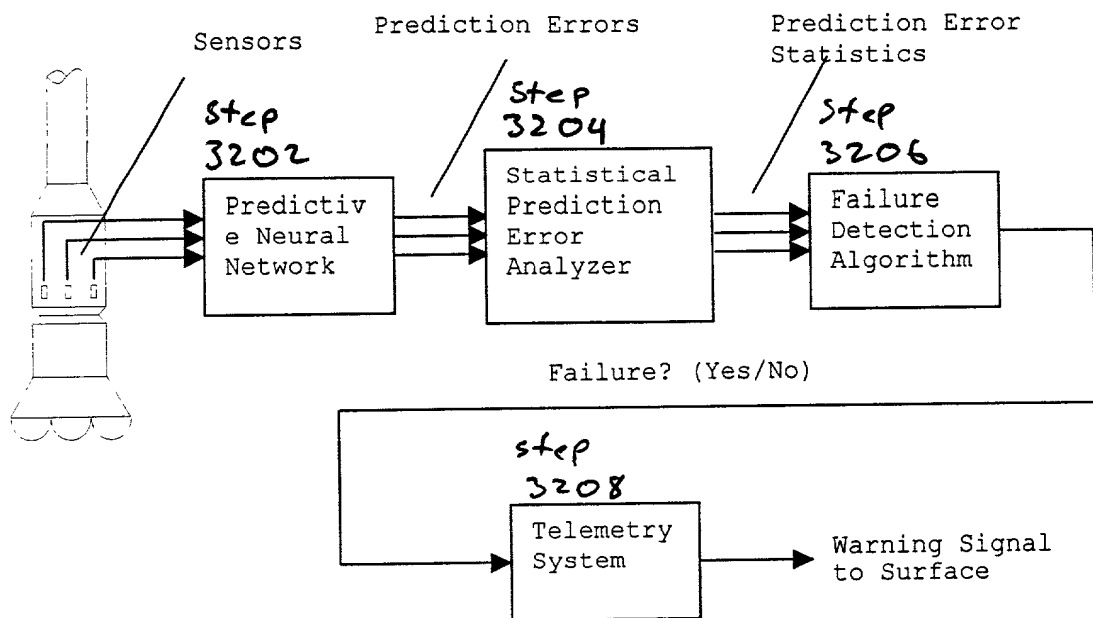


Figure 32 Schematic of ANNPA Bearing Failure Detection Scheme

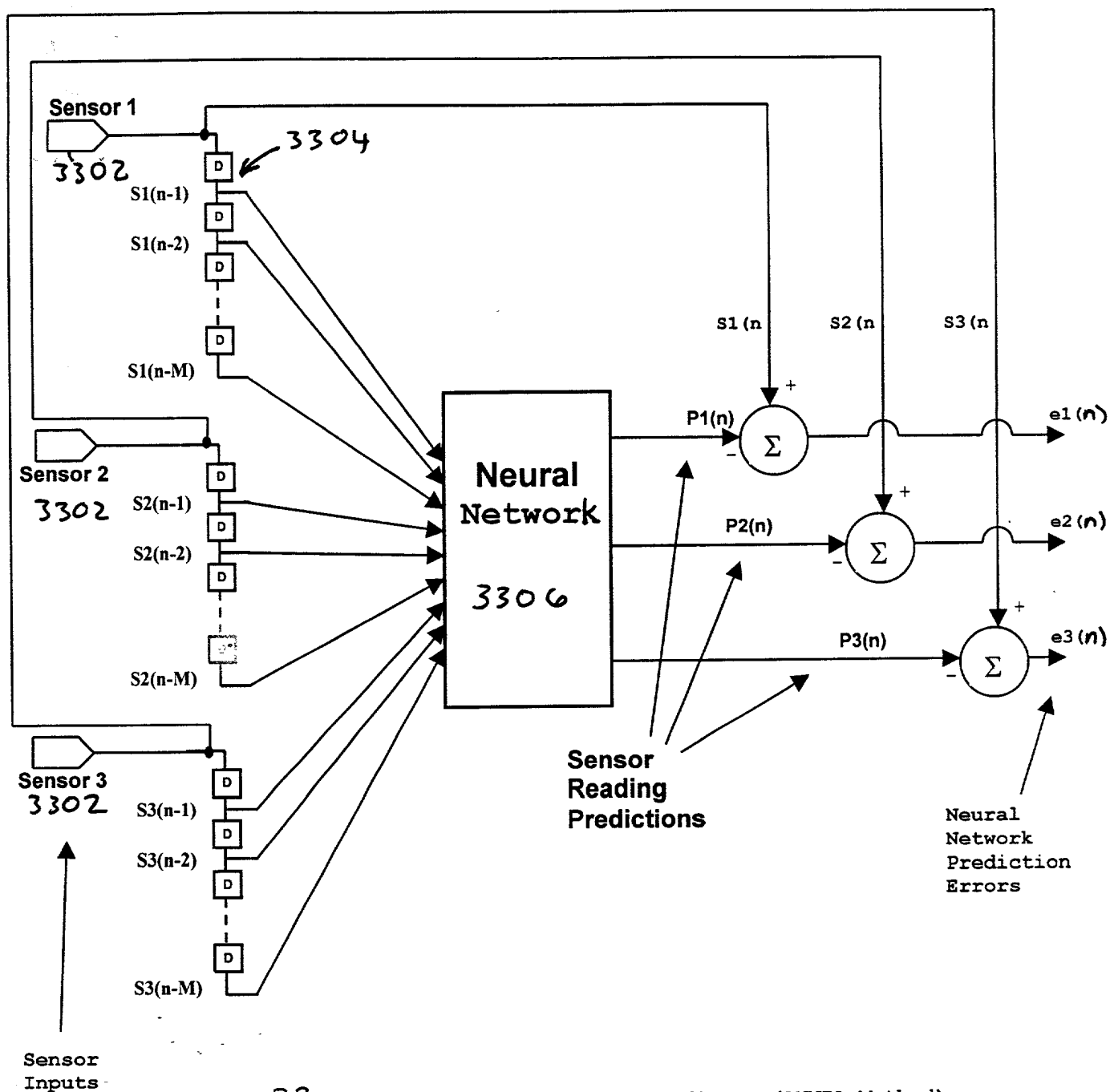


Figure 33 Adaptive Neural Network Predictor (ANNPA Method)

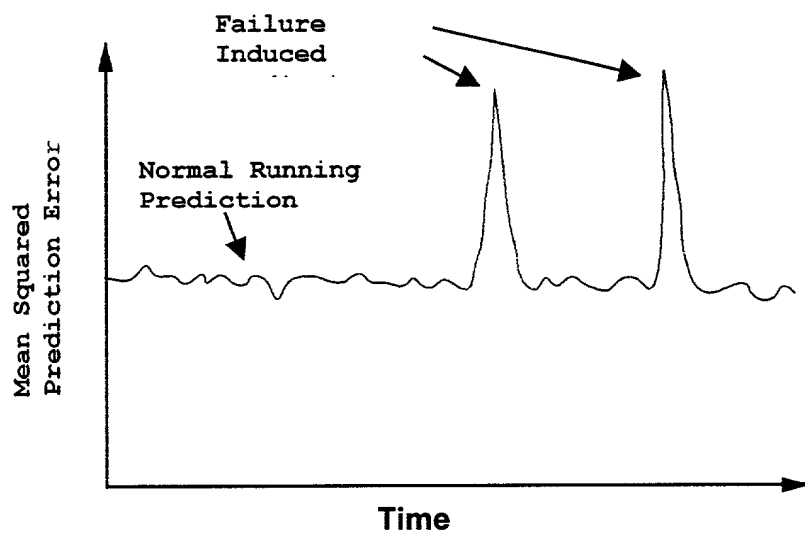


Figure 34 Failure Indications (ANNPA Method)

Acceleration (No Bearing Damage)

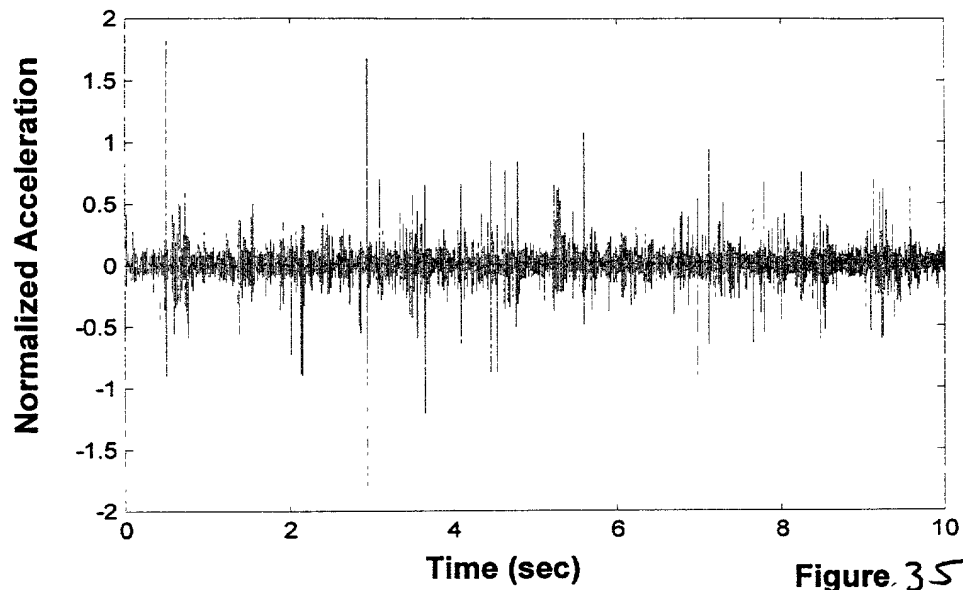


Figure 35

Acceleration Prediction Error (No Bearing Damage)

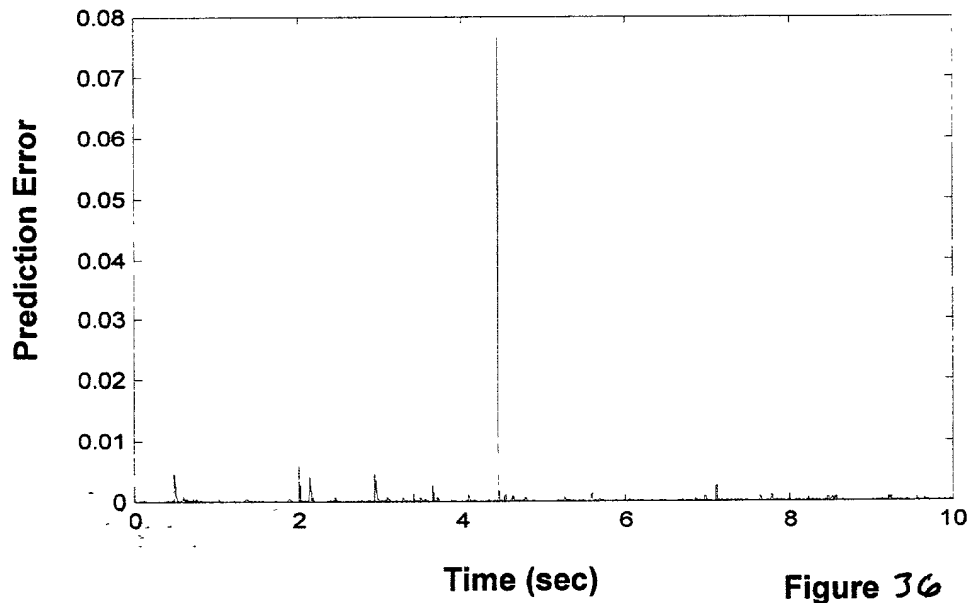


Figure 36

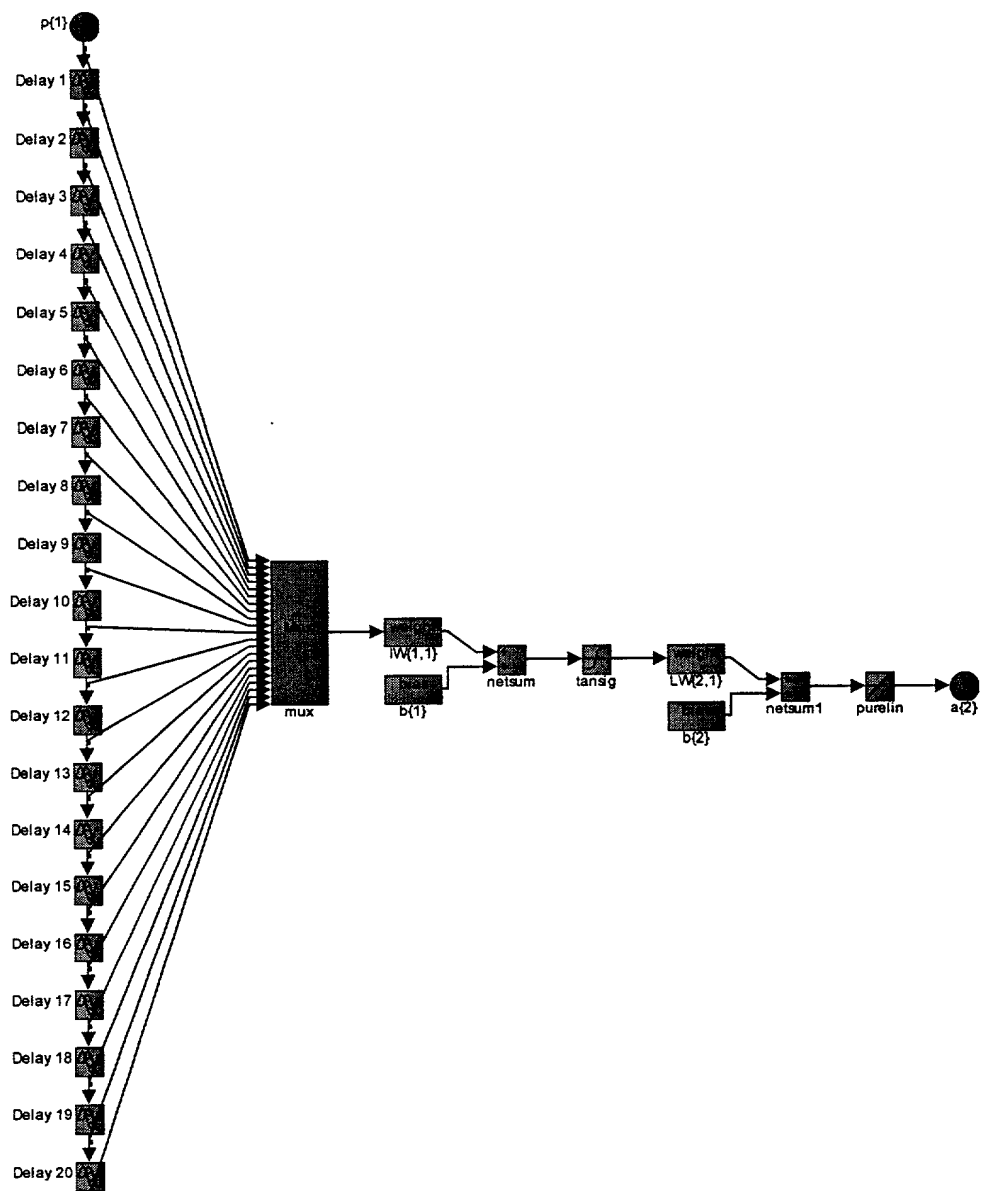


Figure 37

Acceleration (Light Bearing Damage)

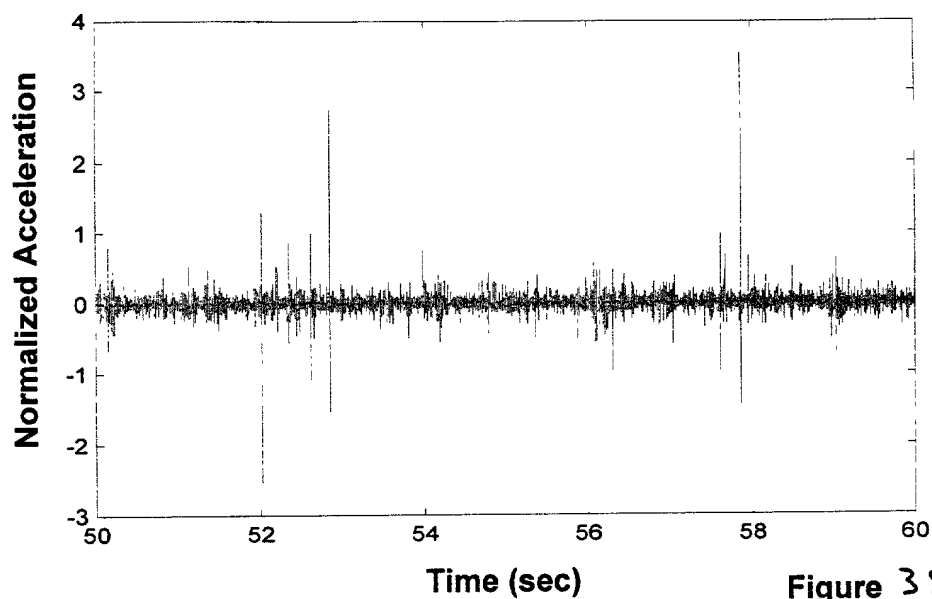


Figure 38

Acceleration Prediction Error (Light Bearing Damage)

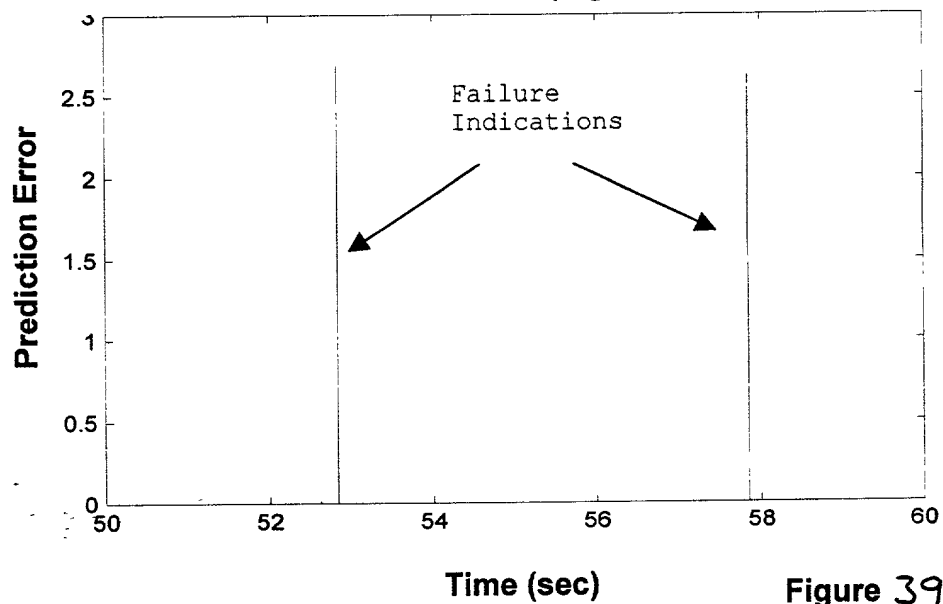


Figure 39

Acceleration (Moderate Bearing Damage)

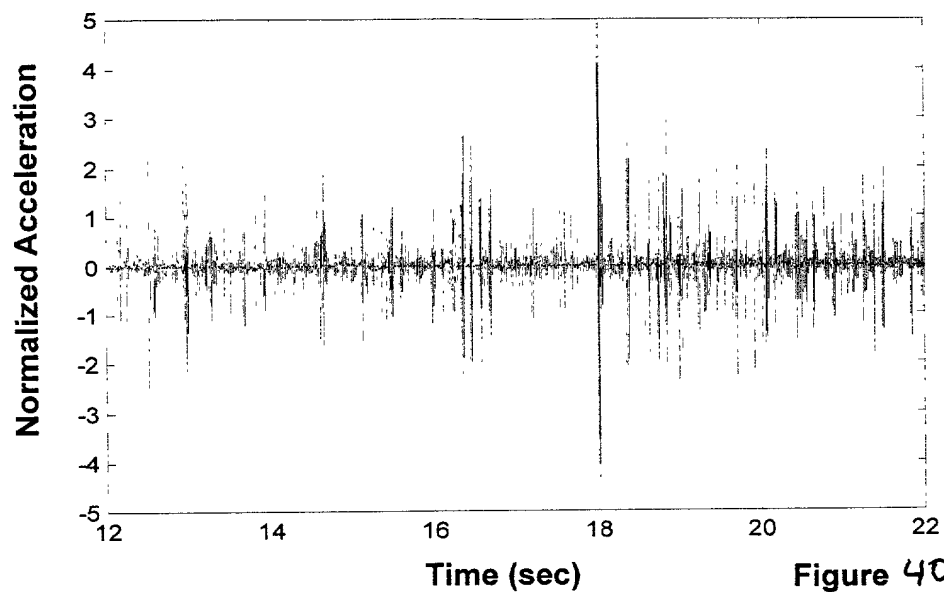


Figure 40

Acceleration Prediction Error (Moderate Bearing Damage)

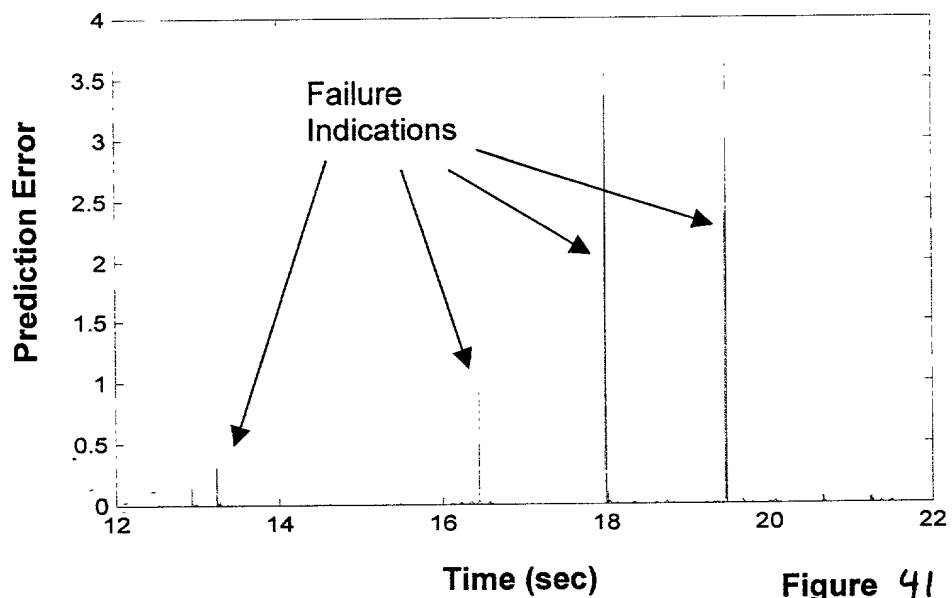


Figure 41

Acceleration (Heavy Bearing Damage)

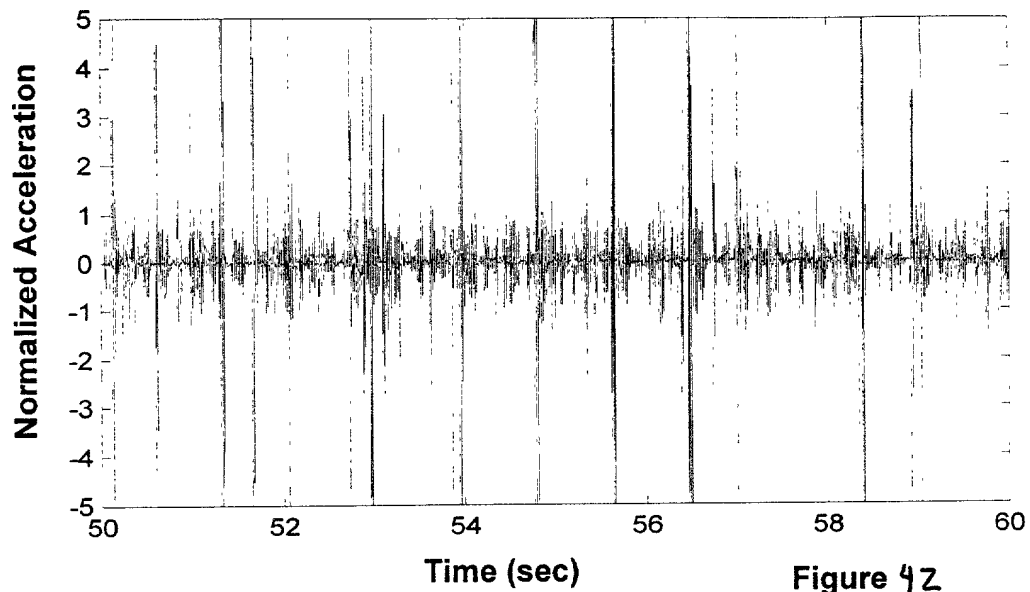


Figure 42

Acceleration Prediction Error (Heavy Bearing Damage)

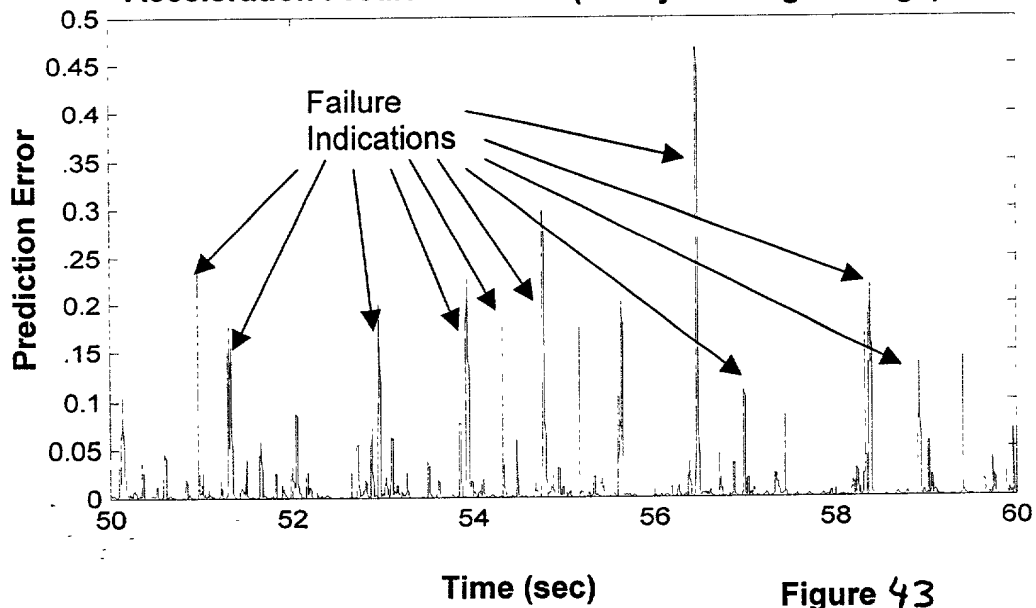


Figure 43

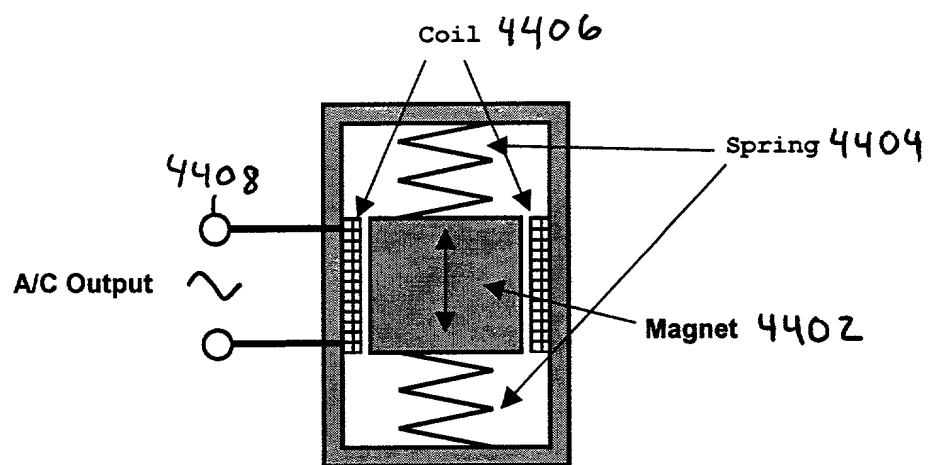


Figure 44 Diagram of Voice Coil Power Generator

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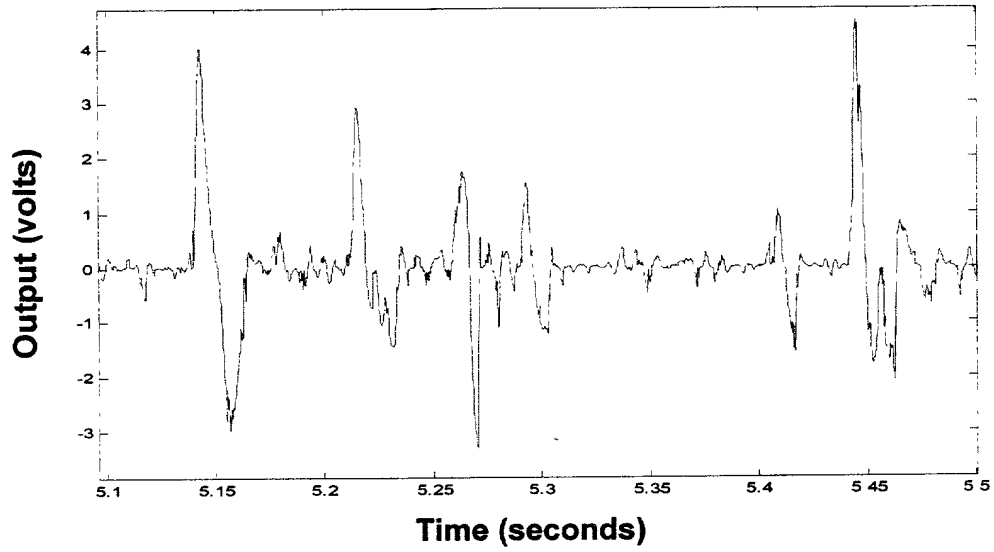


Figure 45 Scaled-Down Prototype Power Generator Output (1000 Ω Load)

The graph shows Surface Drilling Pressure (Y-axis) versus Time (sec) (X-axis). The pressure starts at approximately 2500 psi, labeled "Closed Port". When the "Port Opens (Failure Detected)", the pressure drops sharply to approximately 1800 psi, labeled "Open Port (Failure Indication)". A dashed horizontal line is drawn at the 1800 psi level.

Figure 46 Open Port Failure Indication

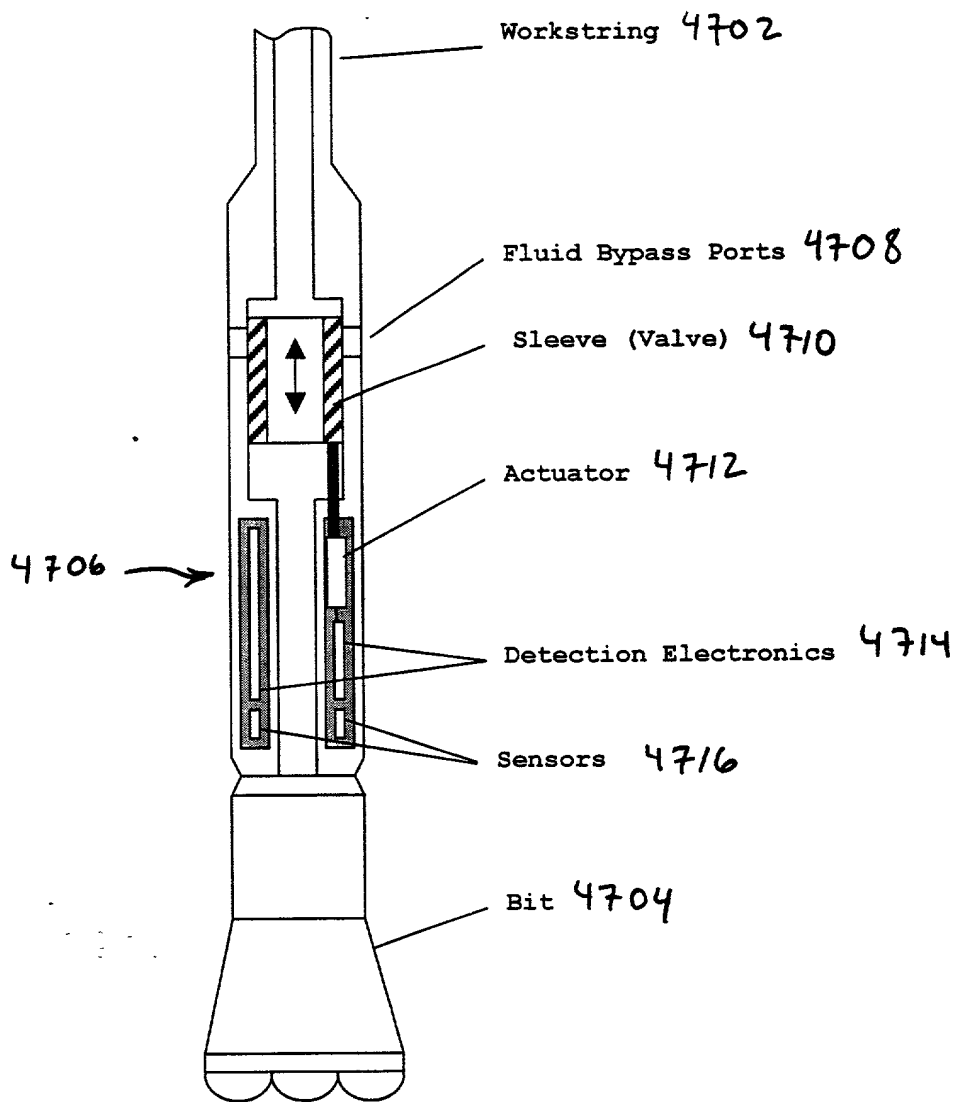


Figure 47 Downhole Tool Schematic

The graph illustrates the relationship between Surface Drilling Pressure and Time. The y-axis represents Surface Drilling Pressure, with marked values at 1800 and 2500. The x-axis represents Time in seconds. The pressure curve begins at a high level (around 2500), labeled 'Closed Port'. It then drops sharply to a minimum level (around 1800), labeled 'Open Port (Failure Indication)'. A horizontal dashed line is drawn at the 1800 pressure level. The pressure then rises sharply back to the high level (around 2500), which is also labeled 'Closed Port'.

Figure 48 Open-Close Signaling Operation

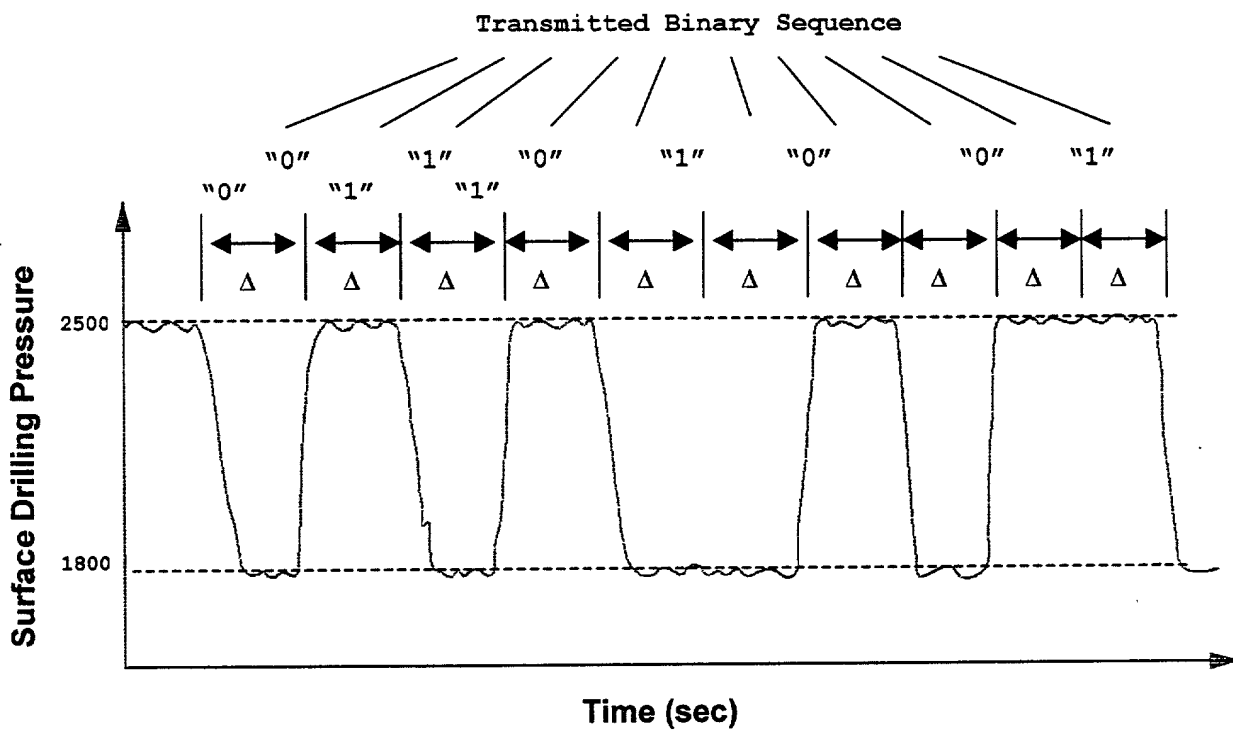


Figure 49 Binary Data Transmission Using Static Pump Pressure Levels

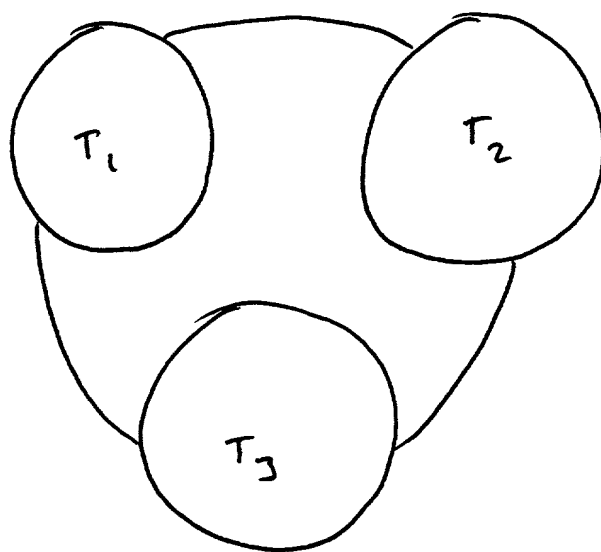


Figure 50

10036105-404701

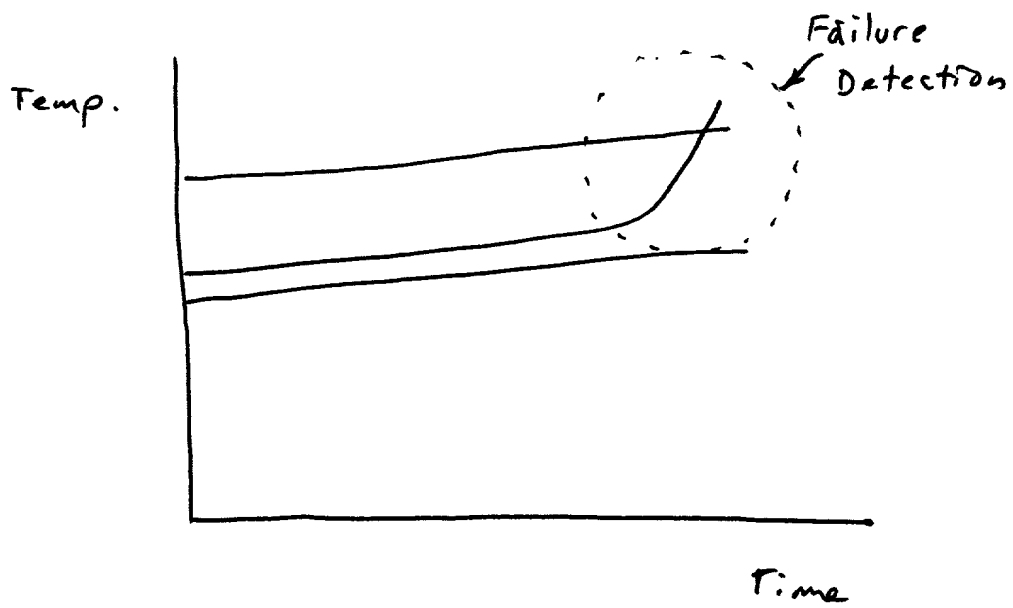


Figure 51

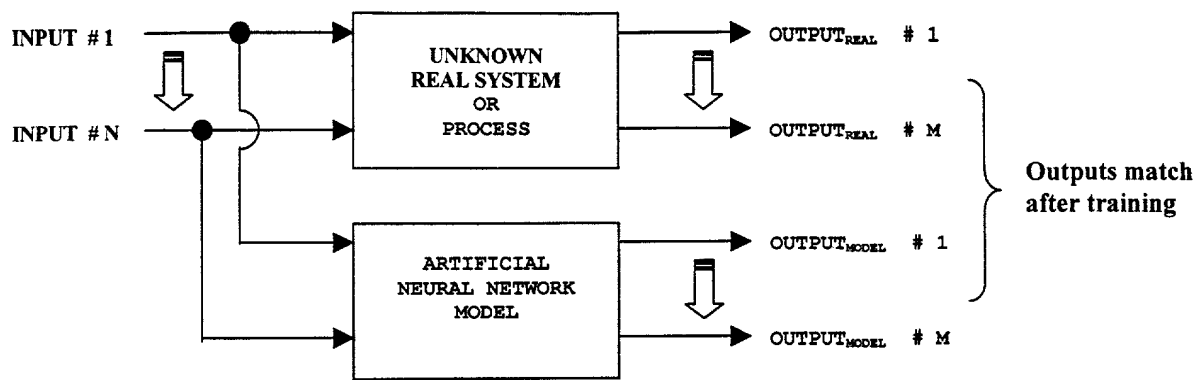


Figure 52 Neural Network Modeling
Real System

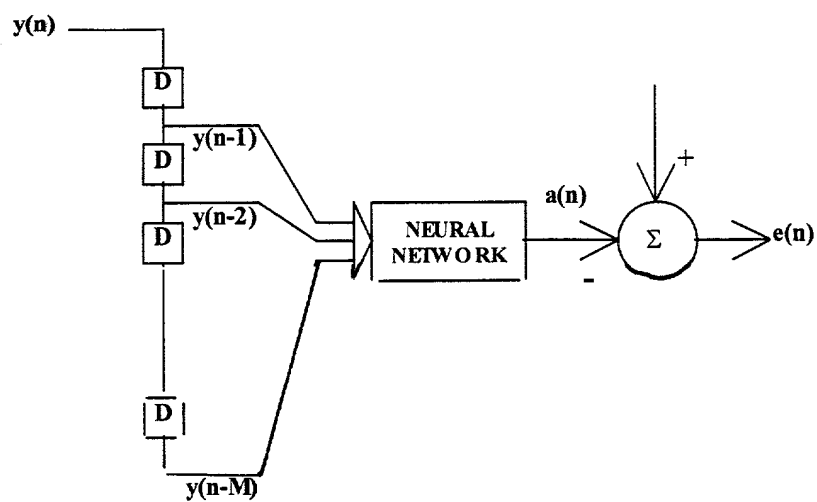


Figure 53

10036105-101701

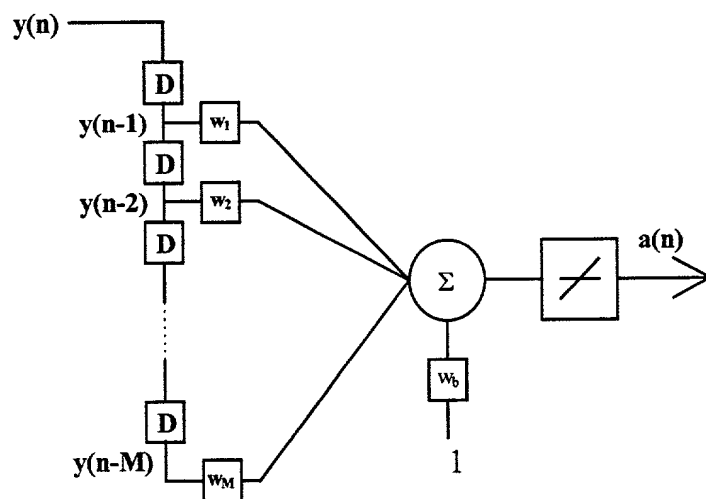


Figure 54 Basic Linear Network

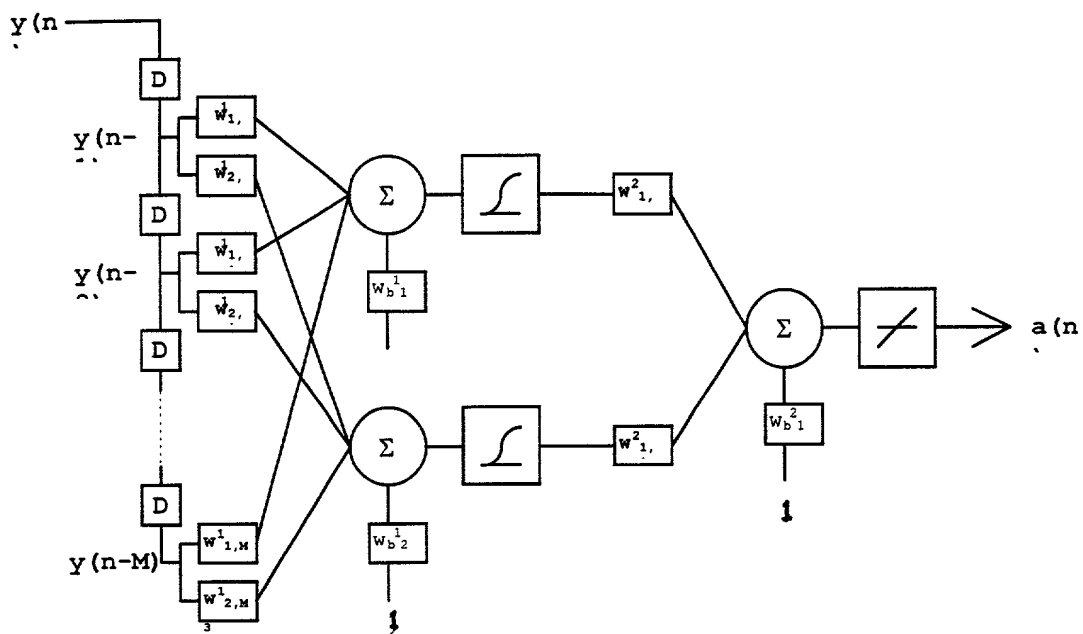


Figure 55

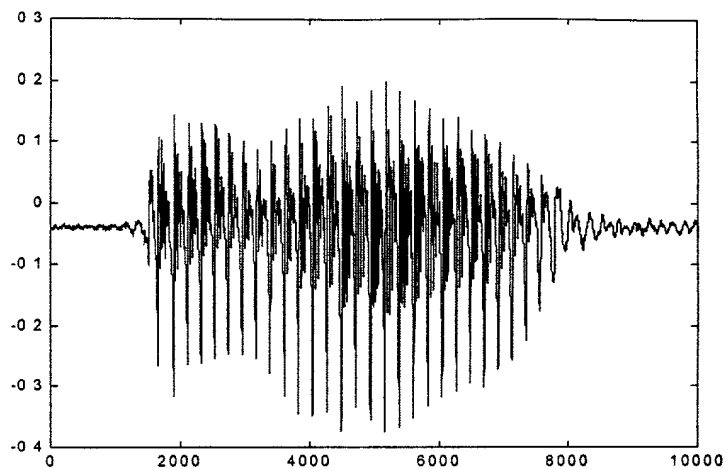
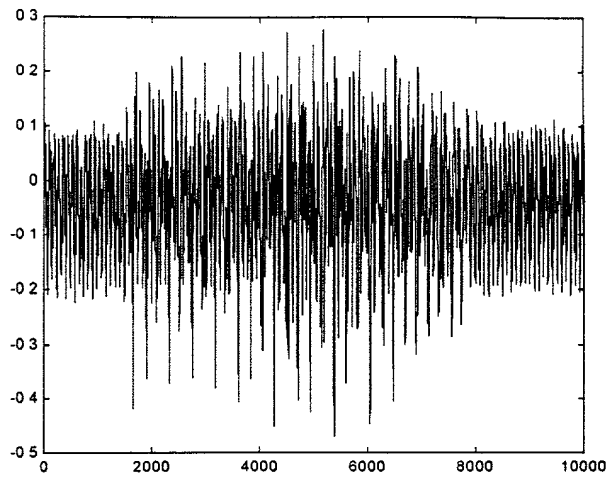
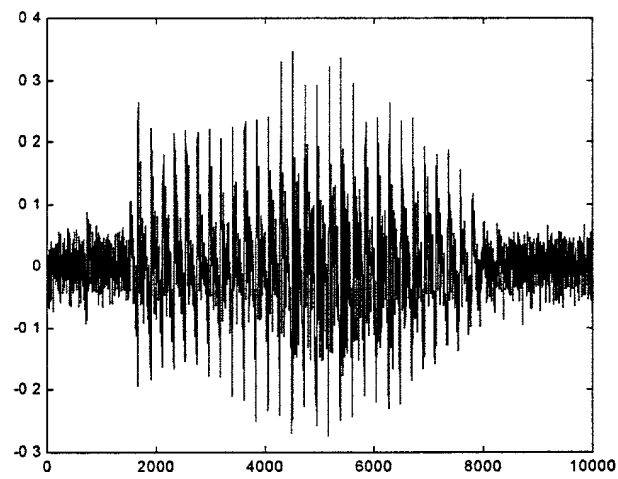


Figure 56

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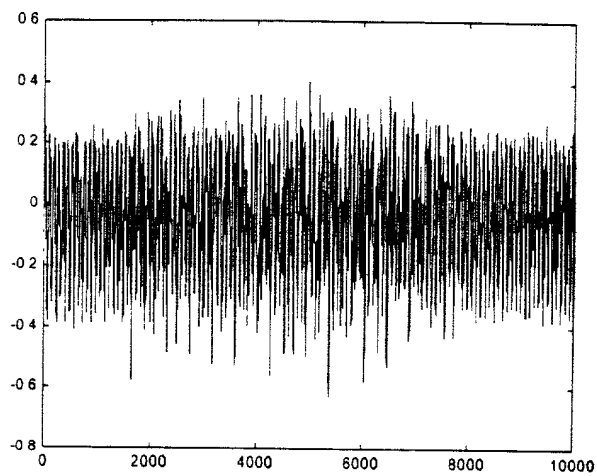


Corrupt Signal S/N Ratio = .95

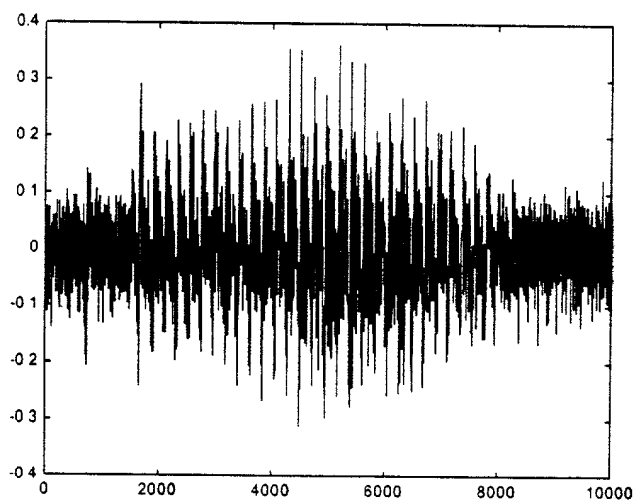


Filtered Signal S/N Ratio = 2.35

Figure 57



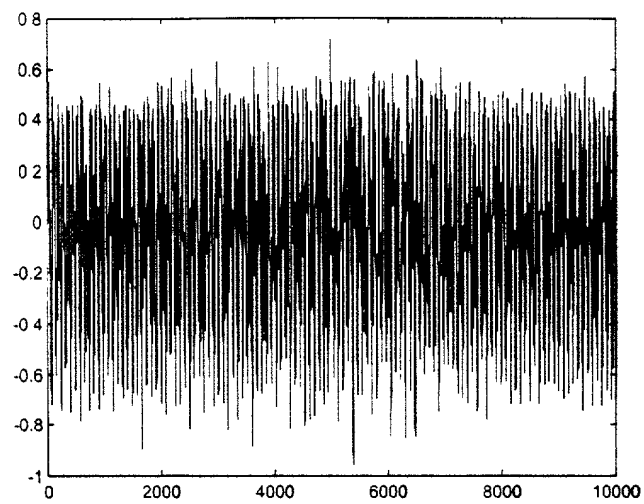
Corrupt Signal S/N Ratio = .24



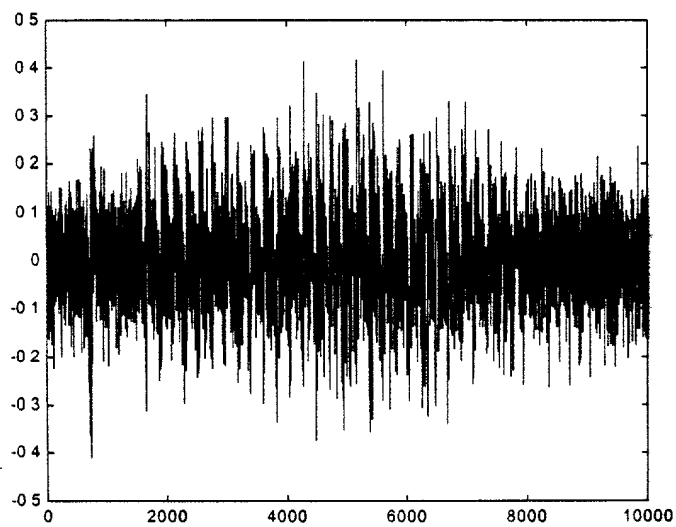
Filtered Signal S/N Ratio = 1.68

Figure 58

10036106-101701

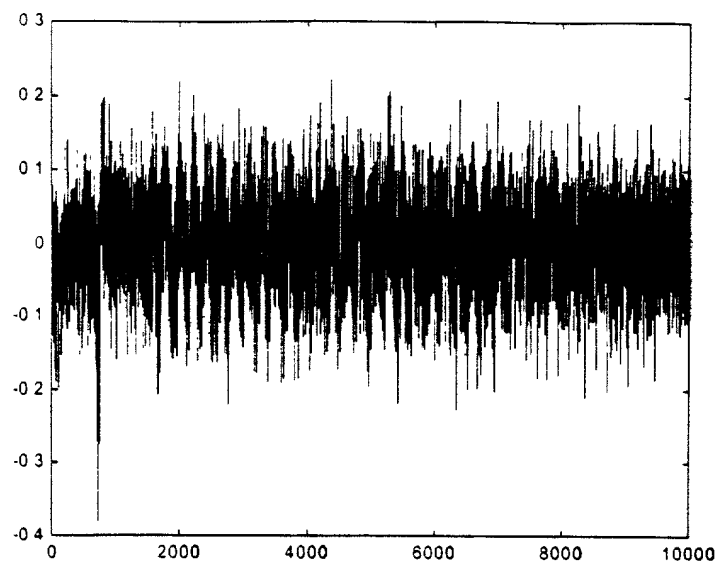


Corrupt Signal S/N Ratio = .06



Filtered Signal S/N Ratio = .89

Figure 59



Linear filter results. S/N = .7457
Figure 60